

Antenna Measurements: Radiated Emissions/Immunity NASA/Orion Mars/Moon Capsule

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Overview



- **Space Exploration (NASA New Role/Mission)**
 - **International Space Station (ISS)**
 - **Space HQ**
 - (Old) Space Shuttle (Glider)
 - (New) Space Ship “Orion” ~ Capsule (Crew Module / Service Module)
 - Blunt Body / Parachute Reentry
 - **EMI Compliance Tests**
 - **NASA/JSC Anechoic Chamber Tests (1m) Un-Shielded Components**
 - Radiated Emissions/Immunity (MIL-STD)
 - **Army/YGP Hanger Tests**
 - **Near-Field Tests (NF->1m) Build-Up Shielded Parts**
 - Sled
 - DART
 - **Far-Field Tests (FF->1m) Full System Integration**
 - Capsule



Outline



- **Introduction**
 - **Space Exploration [NASA (New) Role/Mission]**
 - (New) Space Ship ~ “Orion” Capsule (Space Ship)
 - (Old) Space Shuttle Replacement (Glider)
- **Orion Parachute Reentry ~ High-Altitude A/C Drop Tests**
 - **EMI Tests**
 - SoF (A/C Extraction ~ Orion Prototype)
 - RE/RI (RS/RV) ~ MIL-STDs
 - NASA/JSC-Houston(SAC)
 - (1) Components/(1m) (Un-Shielded)
 - Army/YPG-Yuma(Hanger)
 - (2) Parts Build-Up (Shielded Components/NF->1m) Sled/DART
 - (3) Full System Integration ~ Test Vehicle (Shielded Parts/FF->1m) Capsule (CM/SM)
 - **EMC Results**
- **Conclusions**



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Intro: Space Exploration



- **NASA**
 - **US Space Exploration**
 - **Sites**
 - **JPL ~ Unmanned Missions (Pasadena, CA)**
 - **JSC ~ Manned Missions (Houston, TX)**
 - **KSC ~ Launch Site (Cape Canaveral, FL)**





Intro: NASA/JPL



- **Unmanned Robotic Planetary Exploration**
 - Fly-By/Probes (Inner/Outer Planets)
 - Landers/Rovers (Mars)
- Deep Space Network





Intro: NASA/JSC



- **Manned Missions**
 - **Moon/Mars ~ Asteroids**
 - **Lunar Habitat**
 - **Live in Space**
 - **Mine Moon's Minerals**
 - **Plasma Engine**
 - **Launch to Mars**





Intro: Space Station



- **International Space Station (ISS) ~ \$150B**
 - **HQ / Space Operations**
 - **Research Lab**
 - **Space Environment**
 - **Microgravity**
 - **Observatory**
 - **Factory**
 - **Staging Base**
 - **Moon/Mars**
 - **Orbit**
 - **LEO (~370km/7.7km/s)**
 - **Ionosphere (F Layer)**
 - **Orbits (15.7/day)**





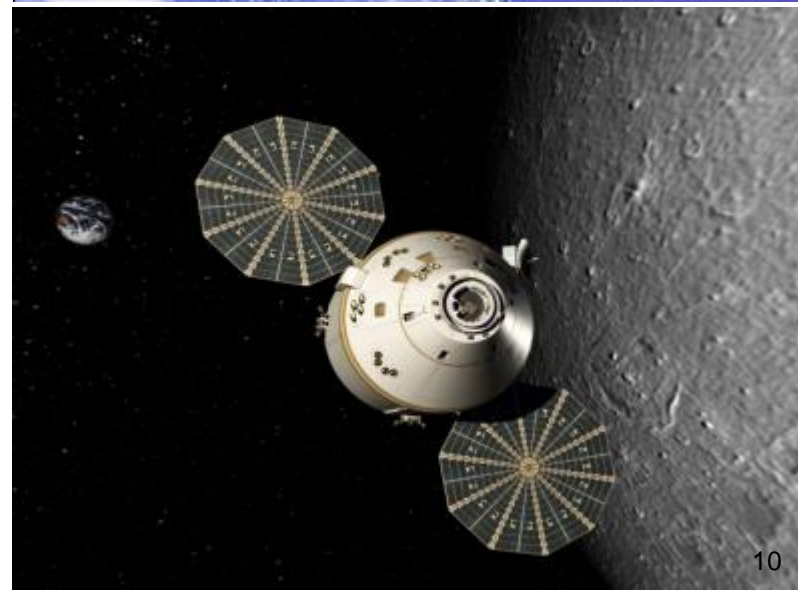
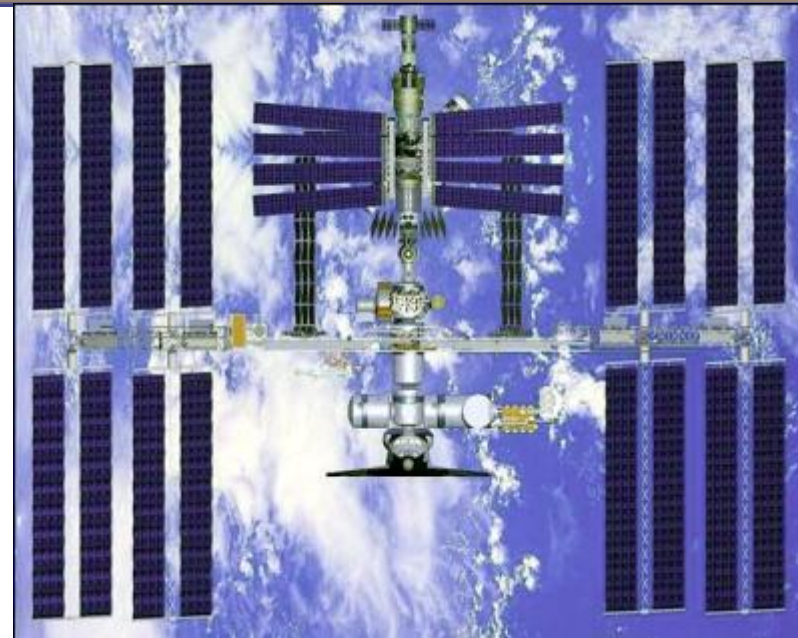
Intro: Past Launch Vehicle (Space Shuttle)



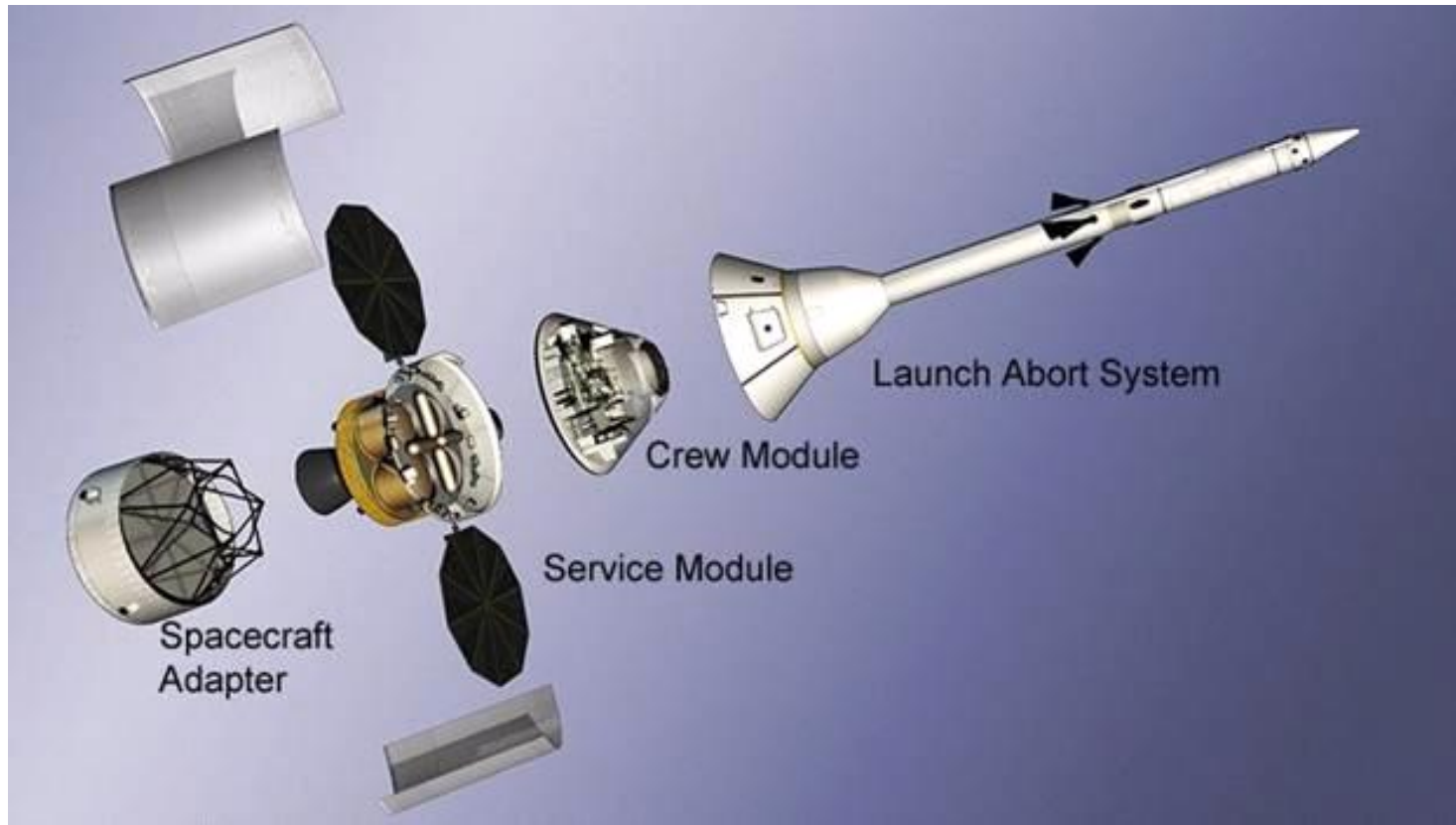
- **Space Shuttle**
 - (Taxi) Terminated
 - Cost (~1/2\$B/Launch=\$65K/Kg)
 - Safety/Reliability (~30y)
 - Maintenance
 - Utility (135)
 - Design Limitations (~80%)
 - LEO
 - Equatorial Orbits
 - <22,700 Kg (Payload)
 - Satellite Launch Platform



- **Short Haul: Earth2LEO(ISS)**
 - Russian
 - Proton
 - Soyuz
 - Commercial
 - SpaceX ~ Dragon Supply Ship
- **Long Haul: Earth2GEO**
 - NASA ---> Moon/Mars(Asteroids)
 - Orion ~ Space Ship
 - Deep Space Exploration

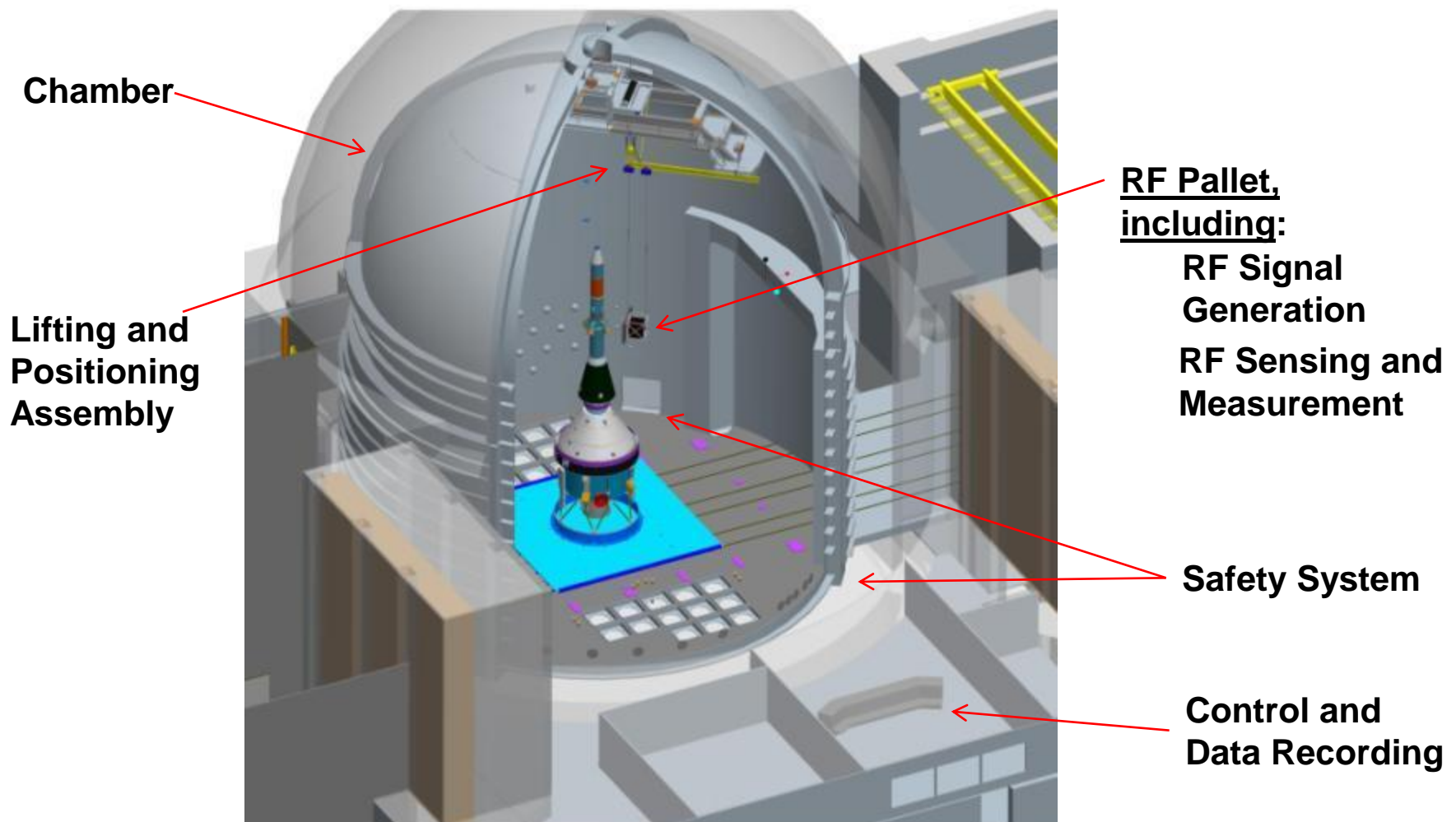


- **Orion**
 - Launch Abort System (LAS)
 - Crew Module (Blunt Body Capsule)
 - Service Module
 - (Adapter)





Space Power Facility: Plumbrook E³ System Test (Reverberation)





Intro: Crew Module Tests NASA/JSC & Army/YPG



- **Crew Module (Capsule)**
 - Designed/Redesigned (**Emerging Technologies**)
 - Earth Reentry
 - Blunt Body
 - Parachute Decent
 - Parachute Drop Tests (C130/C17)
- **Capsule Parachute Assembly System (CPAS)**
 - Components
 - Avionic Tray
 - Mid-Air Delivery System Tray
 - Vehicle
 - Sled/Tub
 - DART
 - Capsule (Prototype)

- **Stages**

- **Extraction**
- **Staggered Chutes**
 - Pilot (1)
 - Drogue(2)
 - Mains(3)
- **Pyrotechnic/Explosives**
 - Initiators/Cutters
- **Mission Critical**
 - **EMI/EMC**
 -





Intro: CPAS

Capsule Parachute Assembly System



- **Parachute Testing**
 - **NASA/JSC**
 - Components (EMI Chamber)
 - **Army**
 - Build-Up (YPG/Hanger)
 - System Integration (YPG/Hanger)
 - **Drop Tests (YPG/Site)**
 - Test/Simulation (Final Landing Stages)
 - Experiments (EMI)
 - C130 (Sled/DART)
 - C17 (Capsule)
 - Analysis
 - -20 dB Penalty





Space Environmental Test (SET) Project

Electromagnetic Environmental Effects (E³) System/Component Tests



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 - **EMI Tests&Analysis**
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 - EMC Results
- Conclusions

(1) JSC: EMI Tests Capsule/Components

- Test Types (RE/RS)
- Test Setups
 - Frequency Bands
 - Polarizations
 - Positions
- Modes
- Test Limits
- Testing (Components): Semi-Anechoic Chamber (1m)
- Test Results





(1) JSC: MIL-STD Tests



- Radiated/Conducted (Emissions/Immunity)**

EMI Test	Description
CE01	30 Hz – 15 kHz Power Leads
CE03	15 kHz – 50 MHz Power Leads
CE07	DC Power Leads Spikes Time Domain
RE02	14 kHz – 10 GHz 13.5 – 15.5 GHz Electric Field
CS01	30 Hz – 50 kHz Power Leads
CS02	50 kHz – 50 MHz Power Leads
CS06	Spikes Power Leads
RS03	14 kHz – 20 GHz, Electric Field

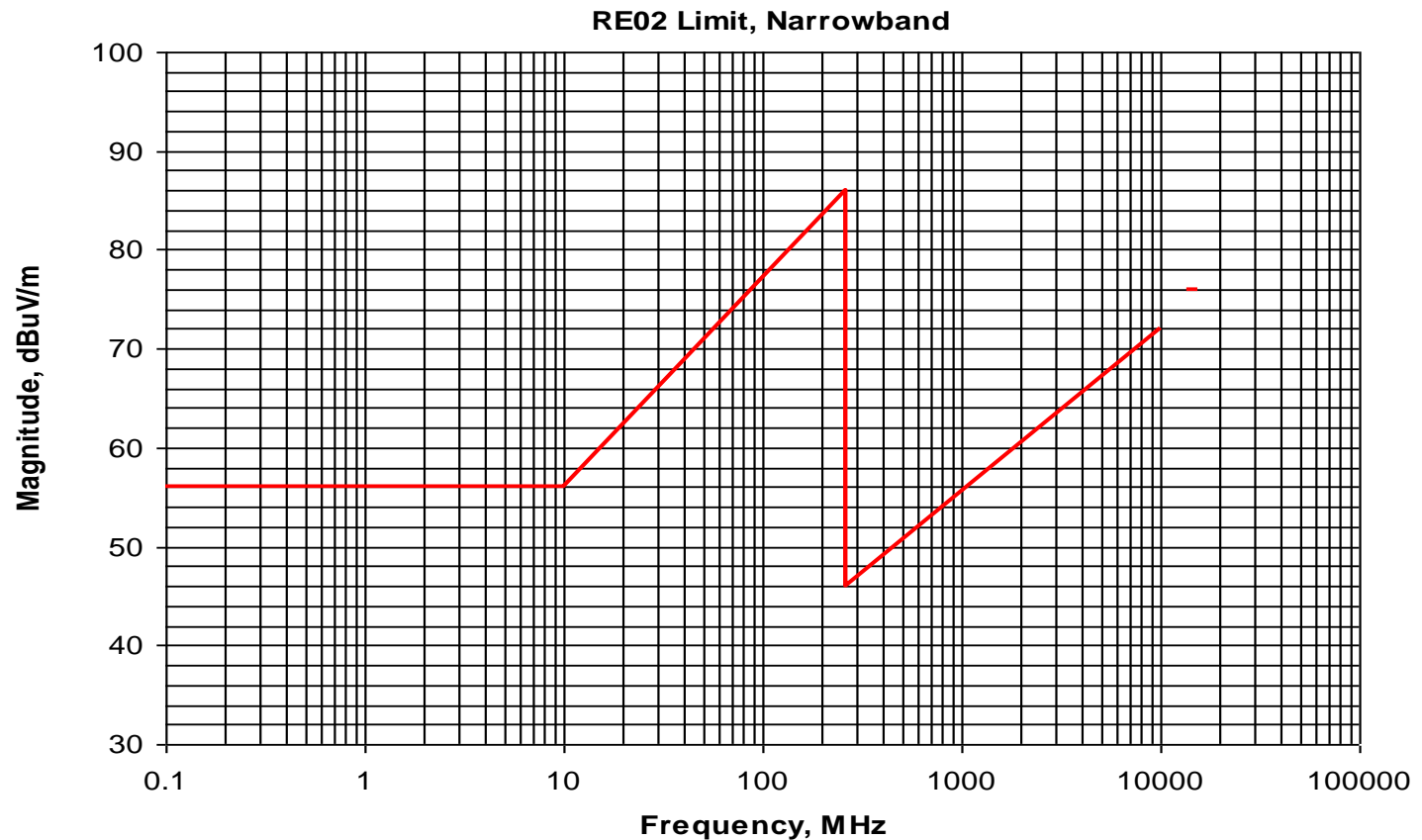
**EMI Test Schedule
US Segment**

EMI Test	Description
CE Low Frequency	20 Hz – 10 kHz Power Leads
CE RF	10 kHz – 100 MHz Power Leads
RE	10 kHz – 1 GHz Electric Field
CS Low Frequency	20 Hz – 10 kHz Power Leads
CS RF	10 kHz – 100 MHz Power Leads
RS	14 kHz – 20 GHz, Electric Field

**EMI Test Schedule
Russian Segment**

(1) JSC: RE02/ISS

- 14 kHz – 15.5 GHz





(1) JSC: RE/Ambients



Test Date: 05/24/2010 Test Time: 7:28 pm - 7:50 pm

Sec:11.4 Steps 8-9 (RE02) Ambient Data (Met the requir.)

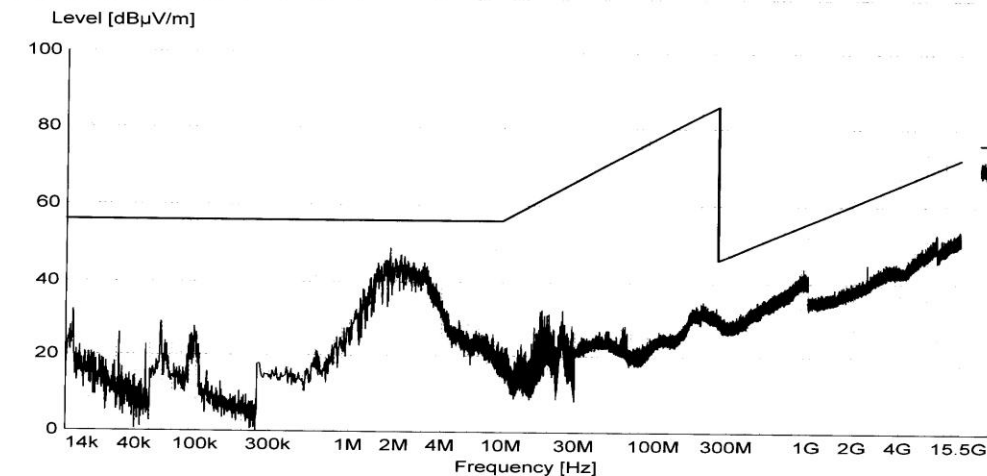
TPS WL1021037
Page 132 of 176

EUT NAME: ROBONAUT 2 (EUT POSITION SERVO)
TEST CLASSIFICATION: Certification
TP.NO: TPS.NO: EV5-10-EMC-009P WL1021037
TEST SITE: JSC B14A Rm. 1000
OPERATOR: Cynthia Hightower, Charles Brooks
TEST SPECIFICATION: Radiation Emissions Space Station Spec. SSP57000
Frequency Range 14 kHz - 10 GHz 13.5 - 15.5 GHz
120Vdc 10 amps fused ~ 5.9 amps meas

ESC
PA
5/24/10

SCAN TABLE: "SSP30237 RE02"

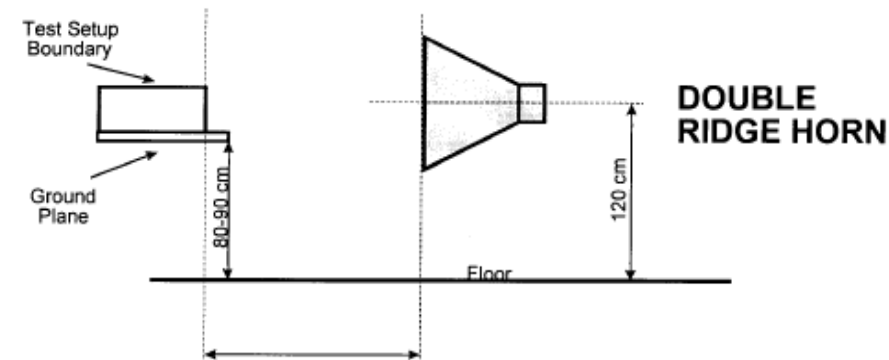
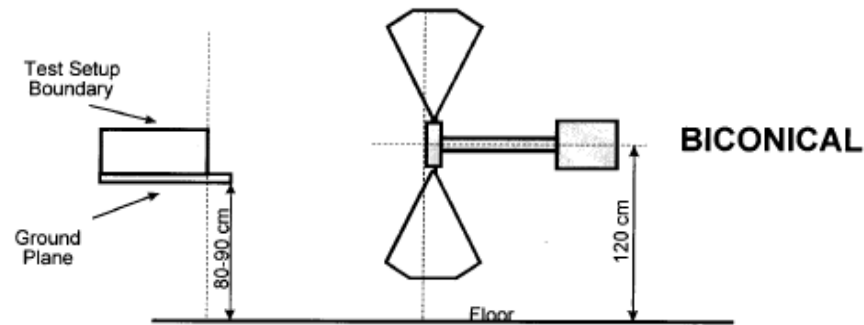
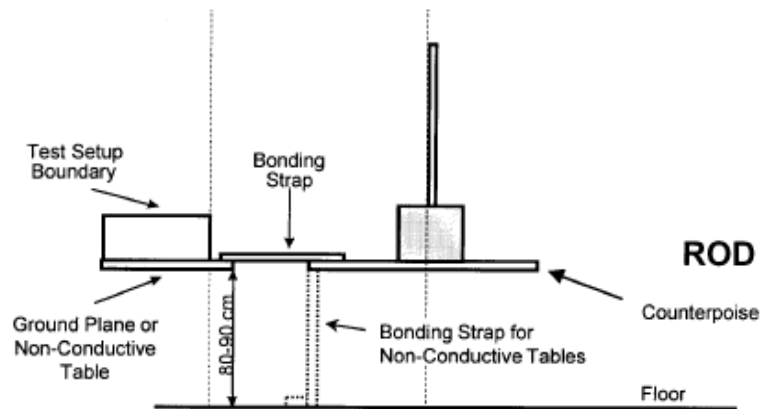
Short Description:		SSP30237 RE02					
Start	Stop	Step	Detector	Meas. Time	IF Bandw.	Transducer	
14.0 kHz	50.0 kHz	100.0 Hz	MaxPeak	10.0 ms	200 Hz	SAS-200/550-1	686
50.0 kHz	250.0 kHz	500.0 Hz	MaxPeak	10.0 ms	1 kHz	SAS-200/550-1	686
250.0 kHz	30.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	SAS-200/550-1	686
30.0 MHz	200.0 MHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	3104C 4708	4714
200.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	93490-1	1109 1110
1.0 GHz	10.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	3115 S/N	6059
13.5 GHz	15.5 GHz	5.0 MHz	MaxPeak	5.0 ms	10 MHz	3115 S/N	6059



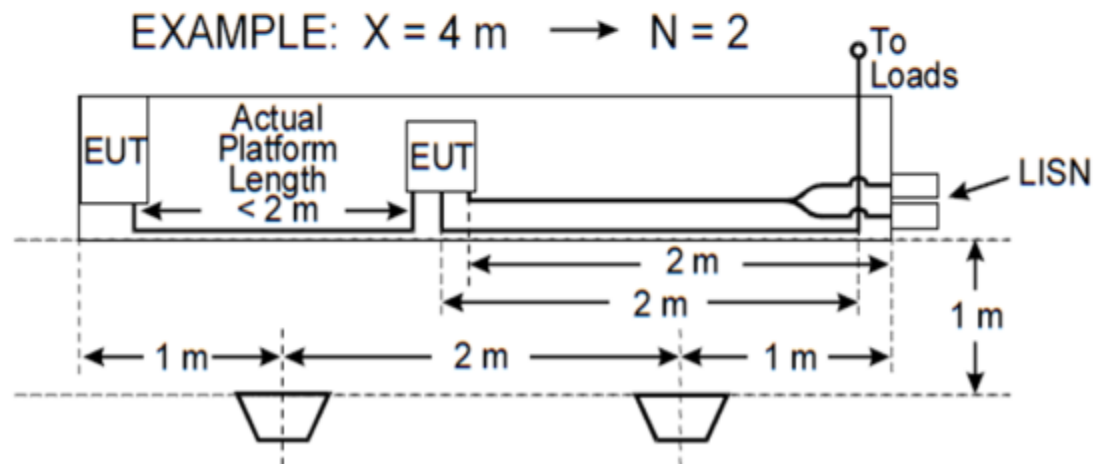
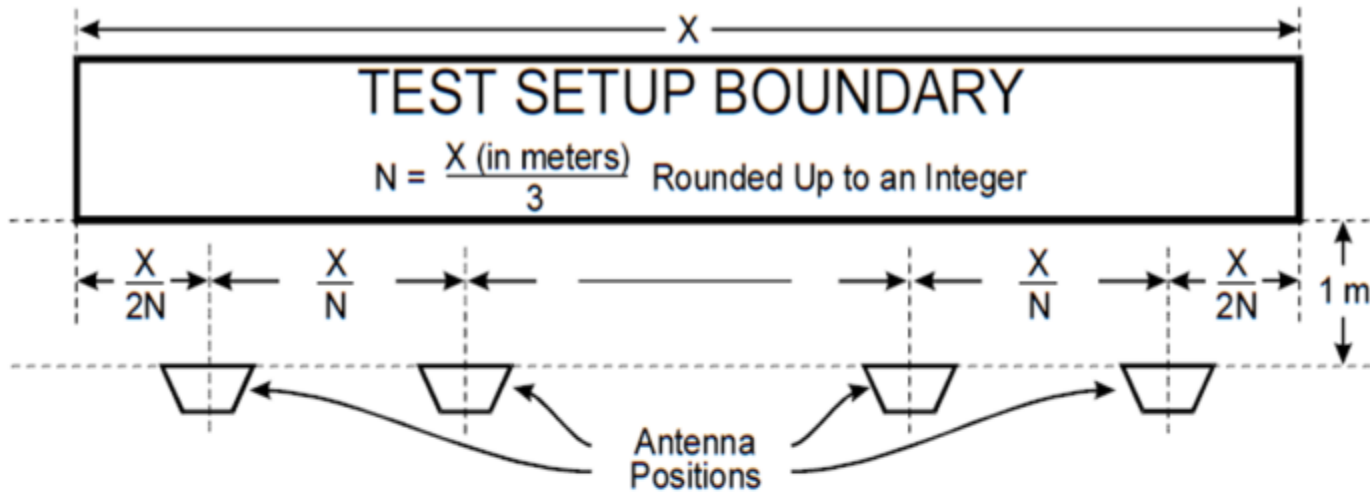
— MES 14-30 AMB w/GSE
— MES 30/200 H AMB w/GSE
— MES 30/200 V AMB w/GSE
— MES 200/1 AMB w/GSE
— MES 1-15.5 H/P AMB w/GSE
— MES 1-15.5 V/P AMB w/GSE
— LIM SSP30237 RE02

SSP 30237 RE02

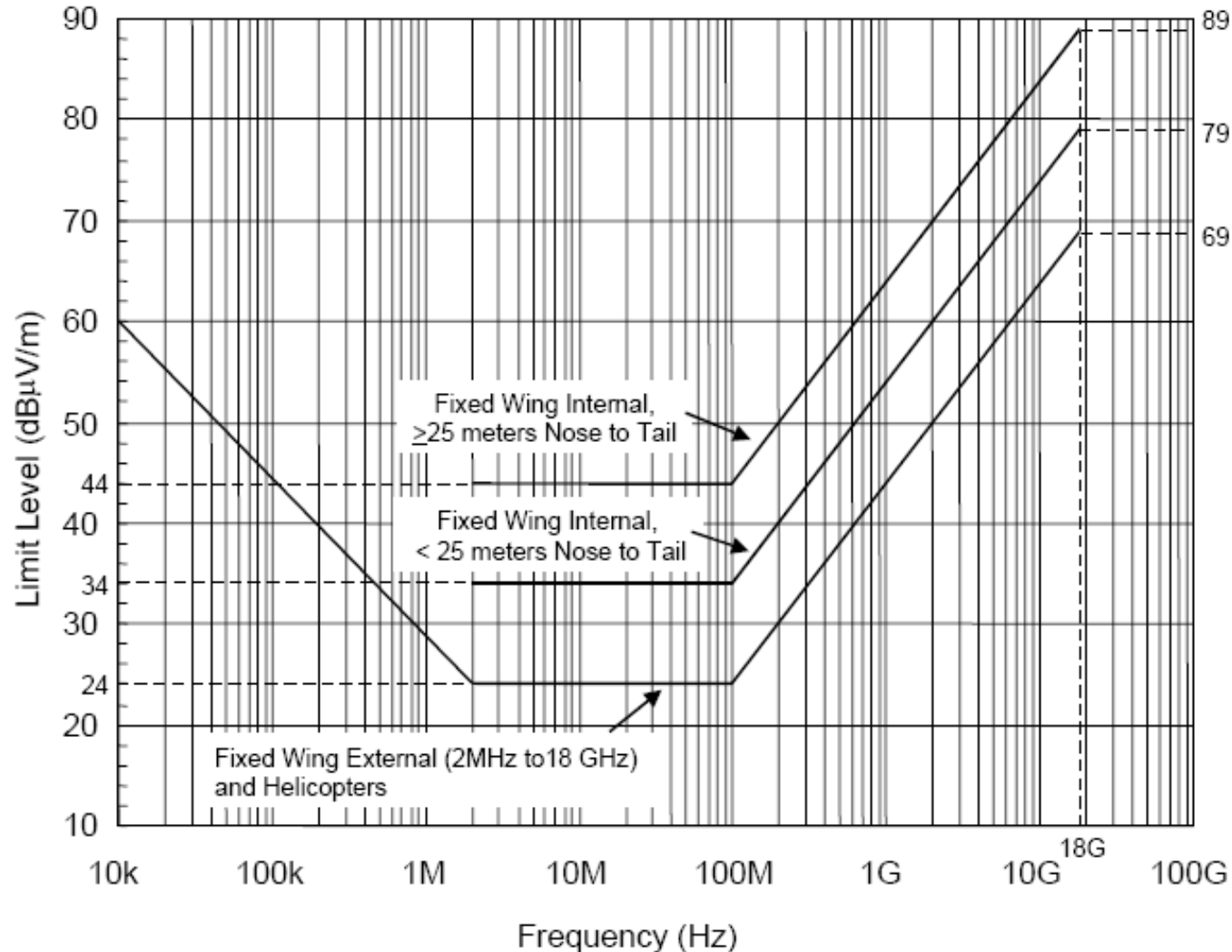
(1) JSC: RE02 Setup (ISS) ~ Bands



(1) JSC: RE02 Setup (ISS) ~ Positions

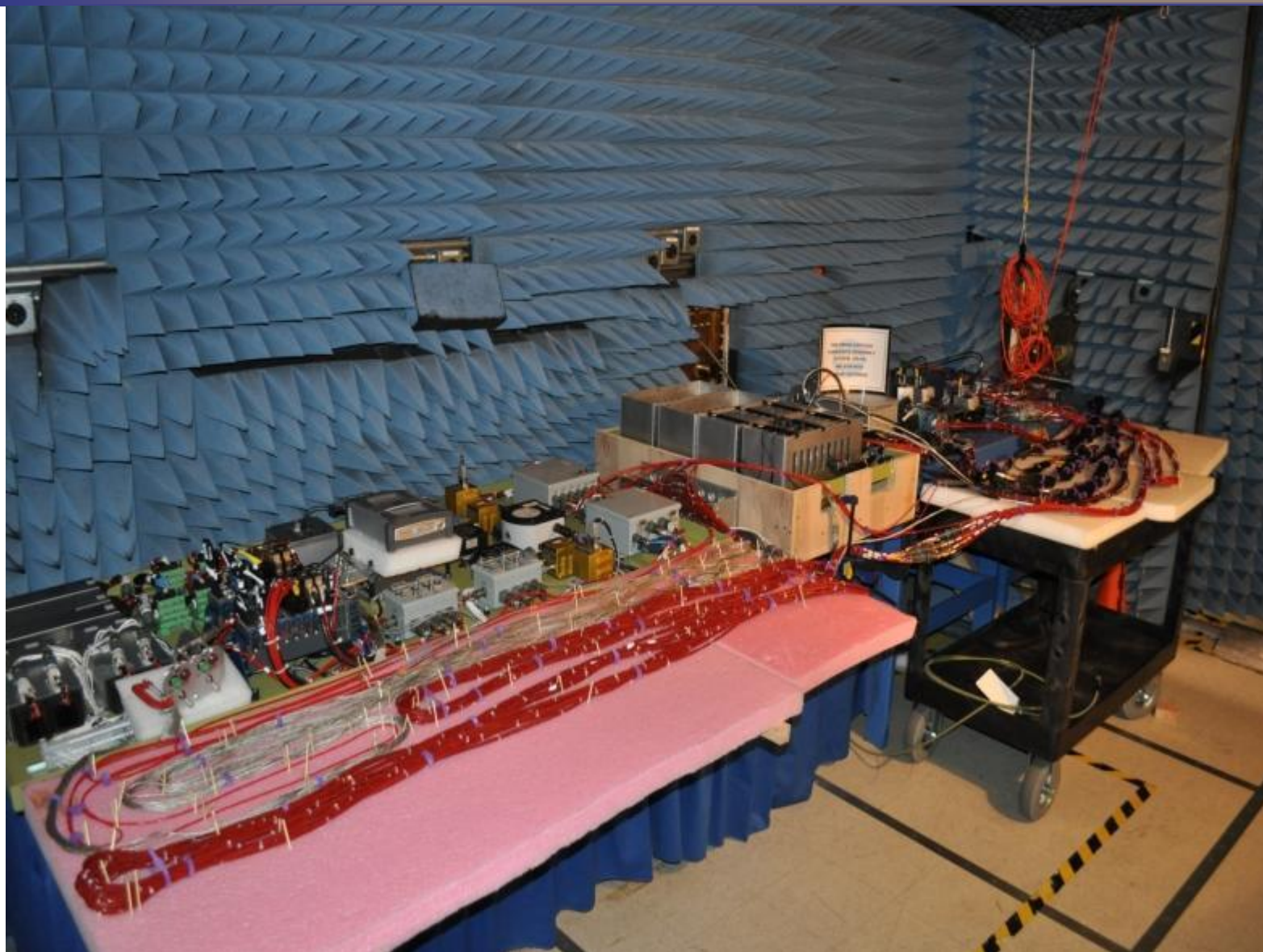


(1) JSC: RE102 Limit (SS)





(1) JSC: CPAS/PCDTV RE102 (SS) Test Setup





(1) JSC: RE102:CPAS/MDS Test Setup





(1) JSC: CPAS RE102 (SS) Test Bands



- **2-30 MHz (VP)**
- **30-200 MHz (HP/VP)**
- **200-1000 MHz (HP/VP)**
- **1-18 GHz (HP/VP)**



(1) JSC: CPAS Test/Analysis



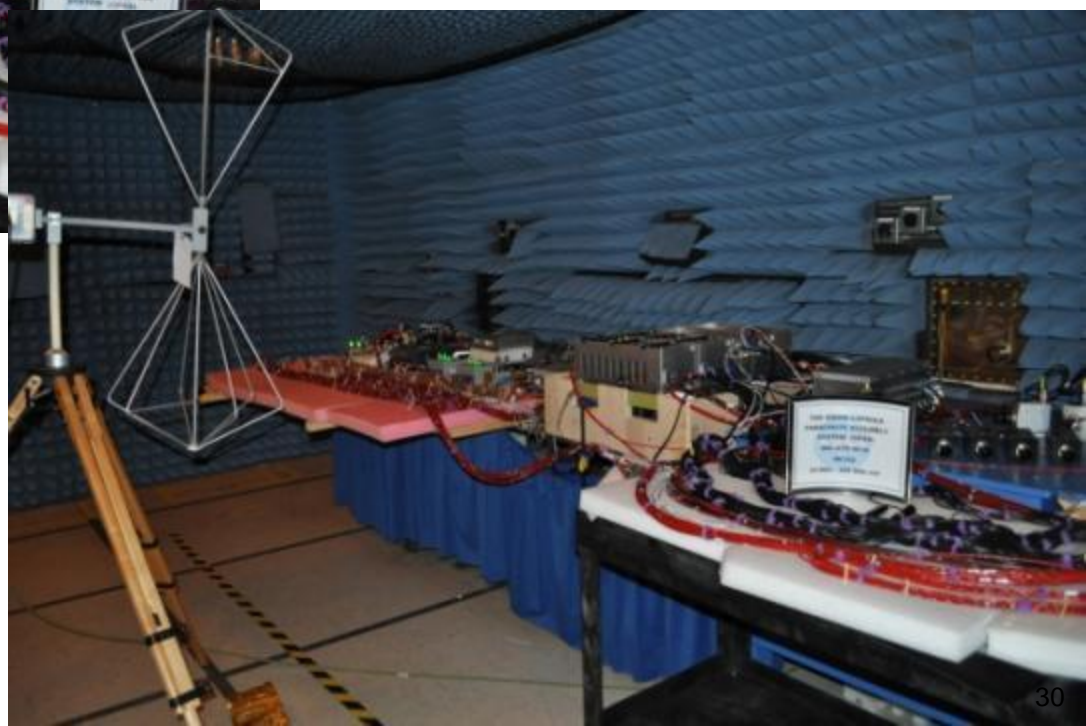
- **Equipment**
 - PCDTV Tray (Unshielded)
 - MDS Tray (Unshielded)
 - Instrumentation Tray (Unshielded)
 - A/C Tray (Unshielded)
 - Video Tray (Unshielded)
 - Cameras (Unshielded)
- **Measurements**
 - RE02

(1) JSC: CPAS RE102 (SS) (2–30 MHz)



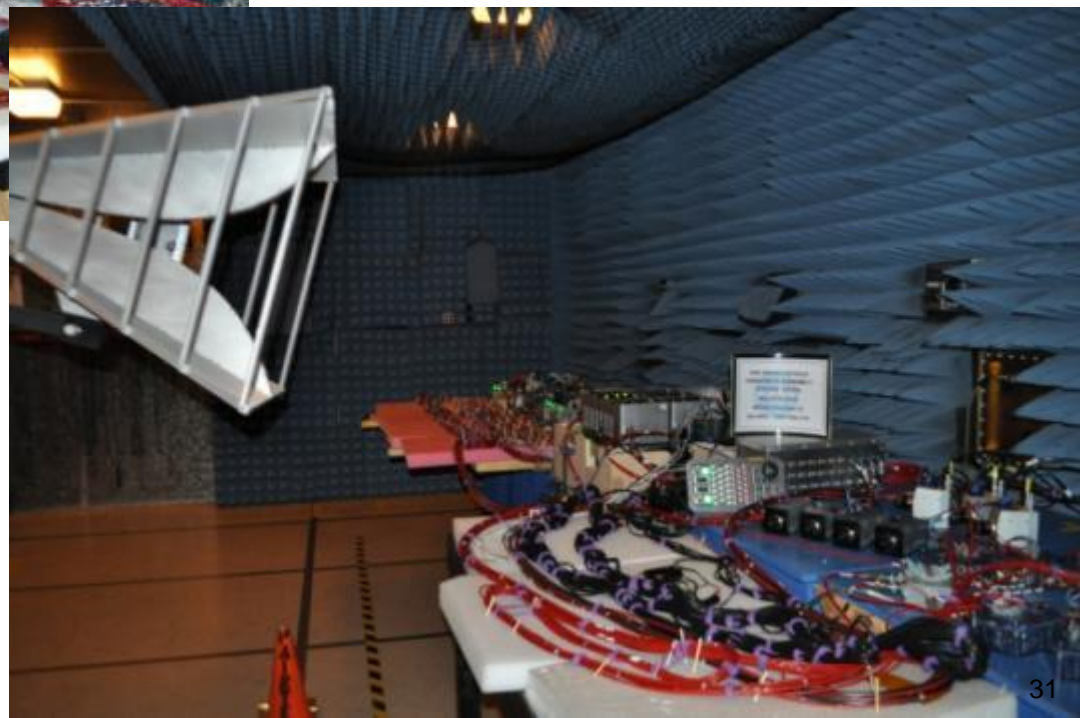


(1) JSC: CPAS RE102 (SS) (30-200 MHz)



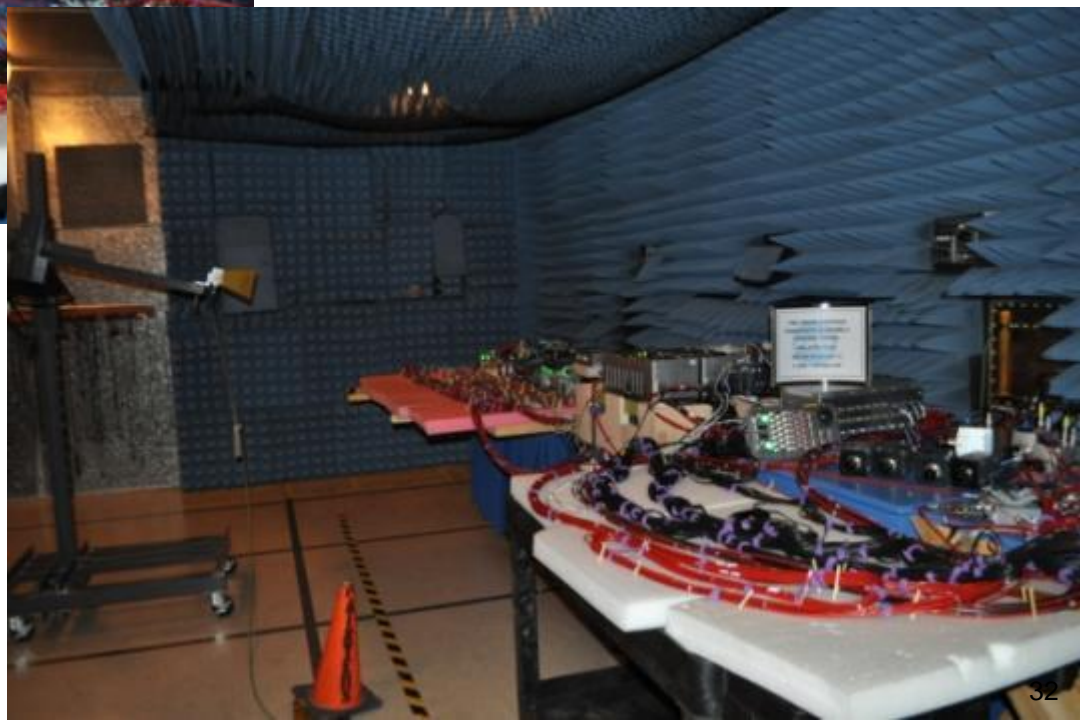


(1) JSC: CPAS RE102 (SS) (200-1000 MHz)





(1) JSC: CPAS RE102 (SS) (1-18 GHz)





(1) JSC: RE102 Limit (SS) w/o Shielding



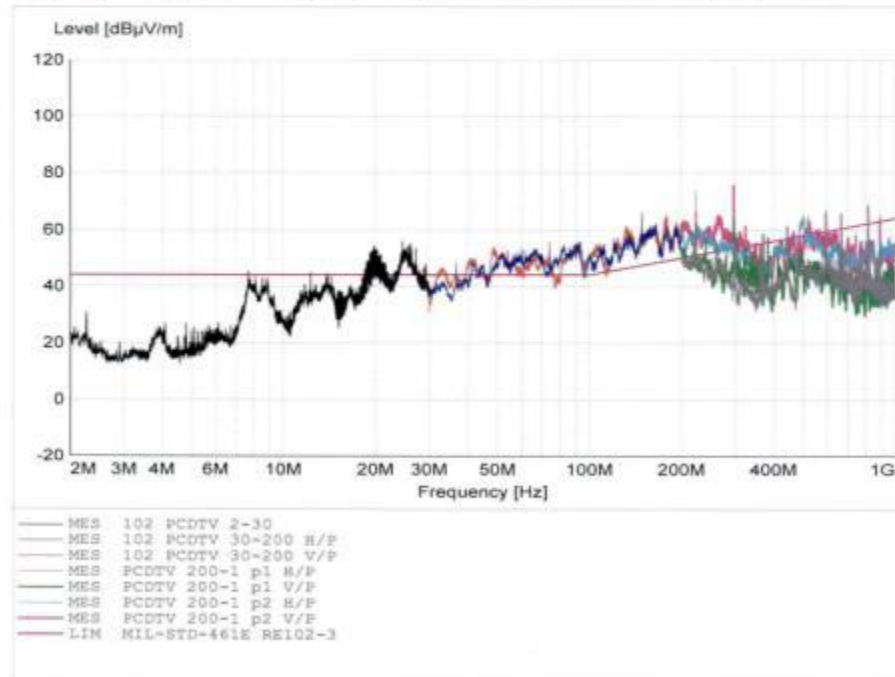
TEST DATE: 05/19/2011 TEST TIME: 2:30 pm - 4:44 pm

The Orion Capsule Parachute Assembly System (CPAS)

TEST CLASSIFICATION: Safety of Flight Battery Operated
TP.NO: W.O.NO: EV5-11-EMC-007P EMCE0-11-011
TEST SITE: JSC B14 Rm. 1000
OPERATOR: Cynthia Nightower
TEST SPECIFICATION: Radiated Emission MIL-STD-461E Freq. Range 2 MHz - 1GHz
Graph Colors: 1. Black 2-30MHz 2. Blue 30-200MHz H/P 3. Red 30-200MHz V/P
Graph Colors: 4. Grey 200-1GHz H/P p1 5. Green 200-1GHz V/P p1
Graph Colors: 6. Lt Blue 200-1GHz H/P p2 7. Violet 200-1GHz V/P p2

SCAN TABLE: "MIL-STD-461E RE102"

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
10.0 kHz	150.0 kHz	500.0 Hz	MaxPeak	15.0 ms	1 kHz	SAS-200/550-1 686
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak	15.0 ms	10 kHz	SAS-200/550-1 686
30.0 MHz	200.0 MHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3104C 4708 4714
200.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3106 S/N 2824
1.0 GHz	18.0 GHz	500.0 kHz	MaxPeak	15.0 ms	1 MHz	3115 S/N 6059





(1) JSC: RE102 Limit (SS) w/o Shielding



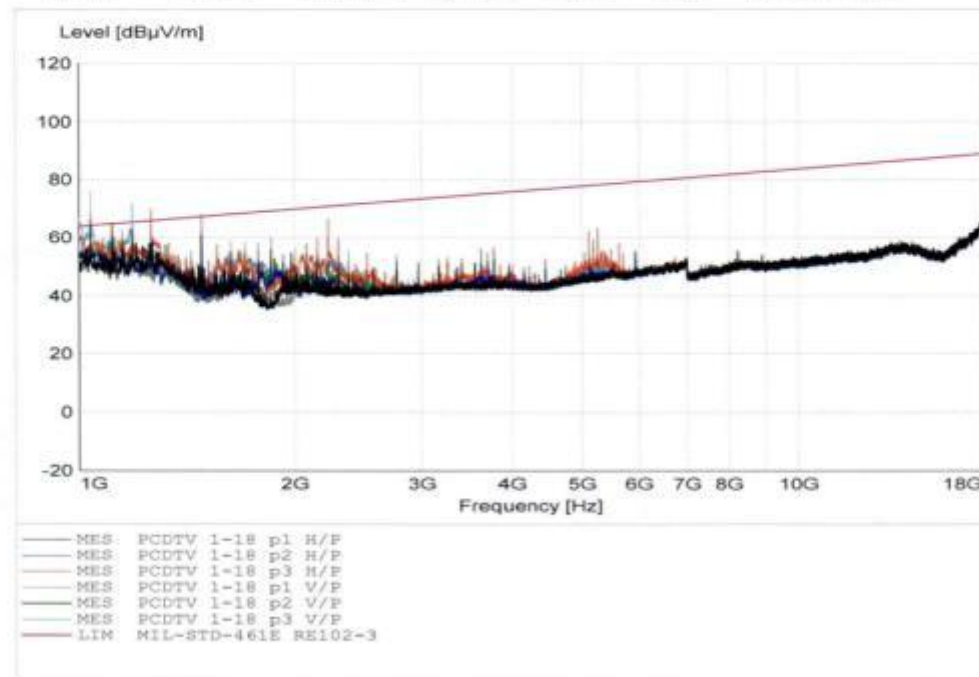
TEST DATE: 05/20/2011 TEST TIME: 8:06 am - 10:23 am

The Orion Capsule Parachute Assembly System (CPAS)

TEST CLASSIFICATION: Safety of Flight Battery Operated
TP.NO: W.O.NO: EV5-11-EMC-007P EMC00-11-011
TEST SITE: JSC B14 Rm. 1000
OPERATOR: Cynthia Hightower
TEST SPECIFICATION: Radiated Emission MIL-STD-461E Freq. Range 1 - 18GHz
Graph Colors: 1.Black 1-18GHz H/P p1 2. Blue 1-18GHz H/P p2
Graph Colors: 3.Red 1-18GHz H/P p3 4. Gray 1-18GHz V/P p1
Graph Colors: 5.Green 1-18GHz V/P p2 6.Lt Blue 1-18GHz V/P p3

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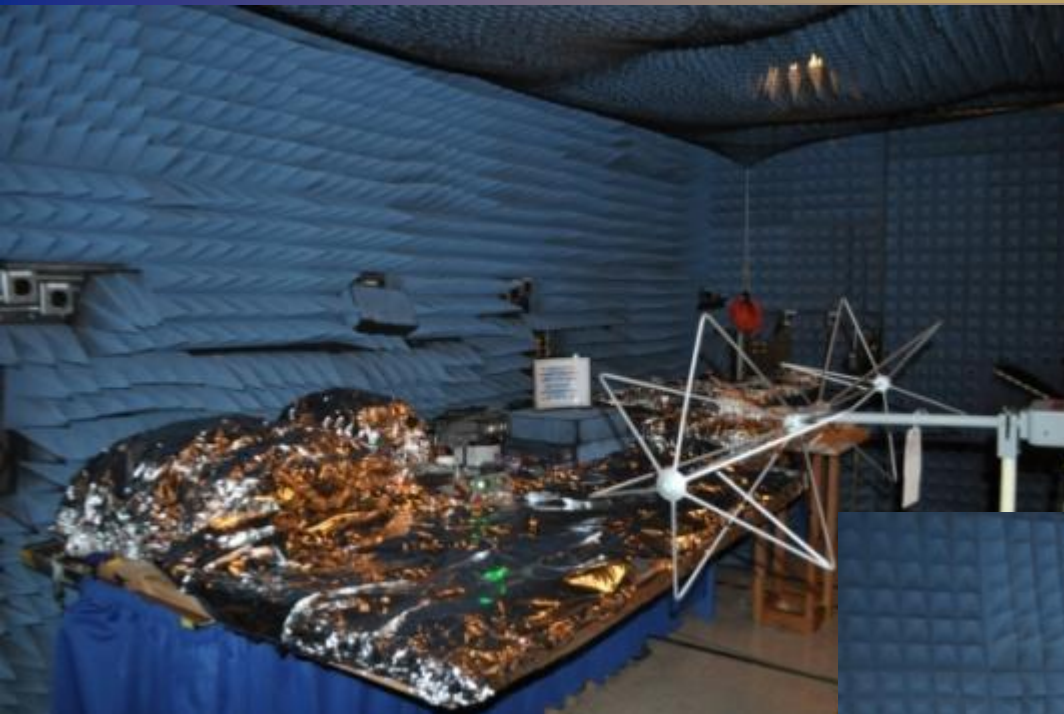


(1) JSC: Shielding



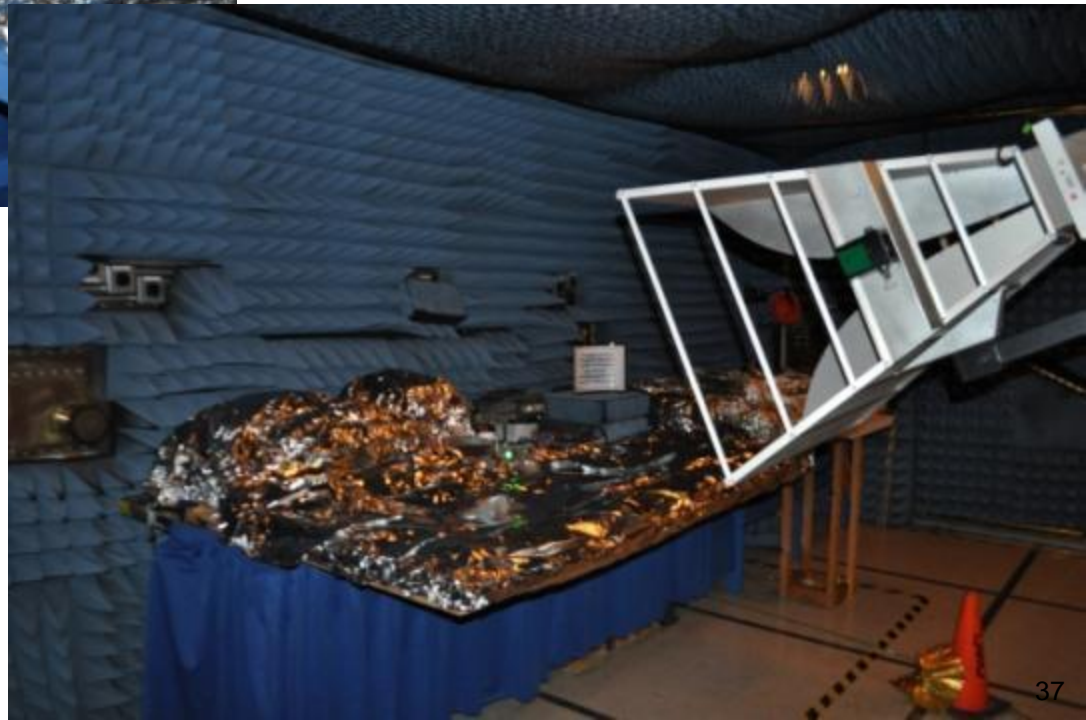


(1) JSC: CPAS RE102 (SS) (30-200 MHz)





(1) JSC: CPAS RE102 (SS) (200-1000 MHz)



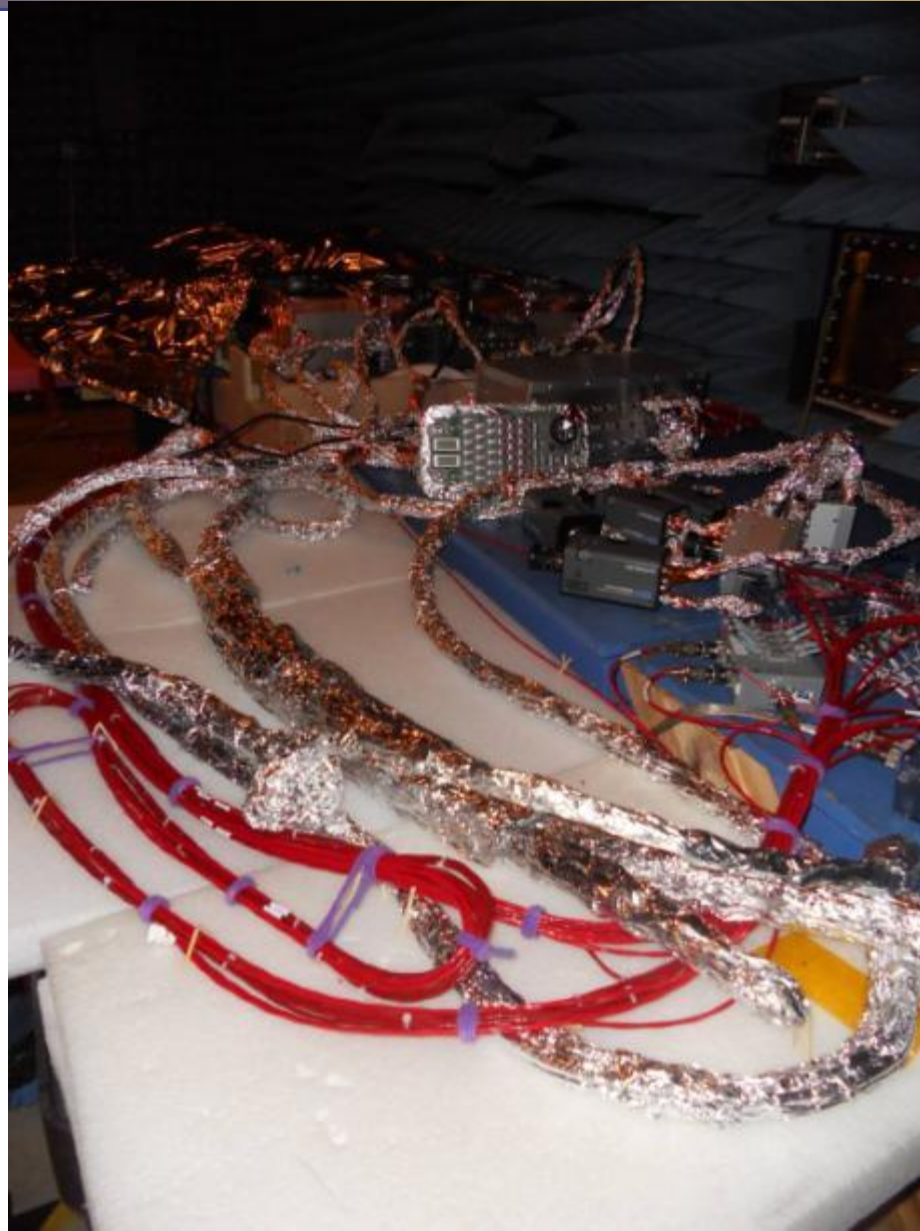


(1) JSC: CPAS RE102 (SS) (1-18 GHz)





(1) JSC: CPAS Shielding Interconnections



(1) JSC: CPAS Shielding Remote Control Wires





(1) JSC: RE102 Limit (SS) w/o Shielding



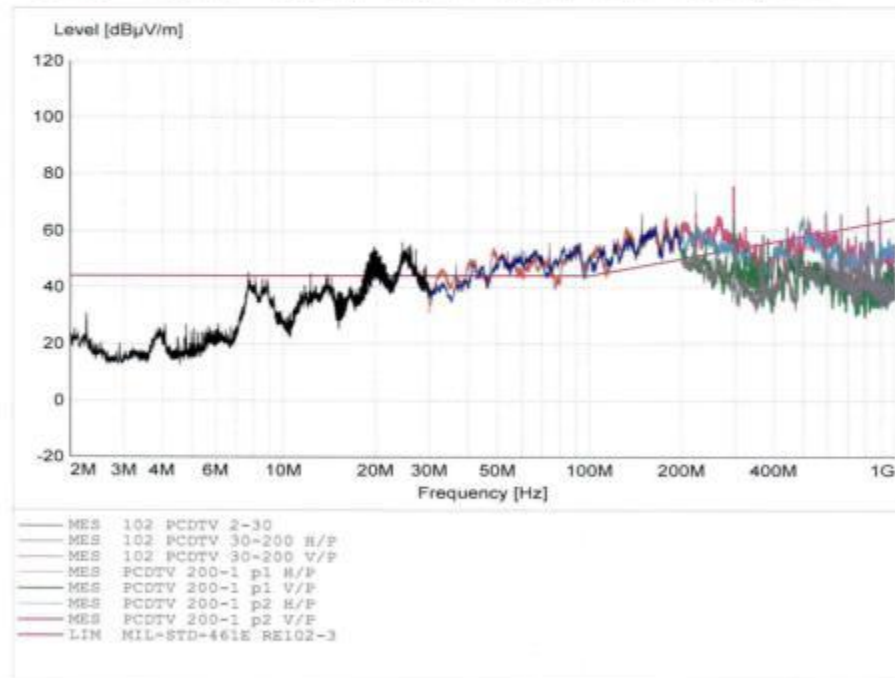
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TEST SITE: JSC B14 Rm. 1000
OPERATOR: Cynthia Nightower
TEST SPECIFICATION: Radiated Emission MIL-STD-461E Freq. Range 2 MHz - 1GHz
Graph Colors: 1. Black 2-30MHz 2. Blue 30-200MHz H/P 3. Red 30-200MHz V/P
Graph Colors: 4. Grey 200-1GHz H/P p1 5. Green 200-1GHz V/P p1
Graph Colors: 6. Lt Blue 200-1GHz H/P p2 7. Violet 200-1GHz V/P p2

SCAN TABLE: "MIL-STD-461E RE102"

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
10.0 kHz	150.0 kHz	500.0 Hz	MaxPeak	15.0 ms	1 kHz	SAS-200/550-1 686
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak	15.0 ms	10 kHz	SAS-200/550-1 686
30.0 MHz	200.0 MHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3104C 4708 4714
200.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3106 S/N 2824
1.0 GHz	18.0 GHz	500.0 kHz	MaxPeak	15.0 ms	1 MHz	3115 S/N 6059





(1) JSC: RE102 Limit (SS) w/ Shielding



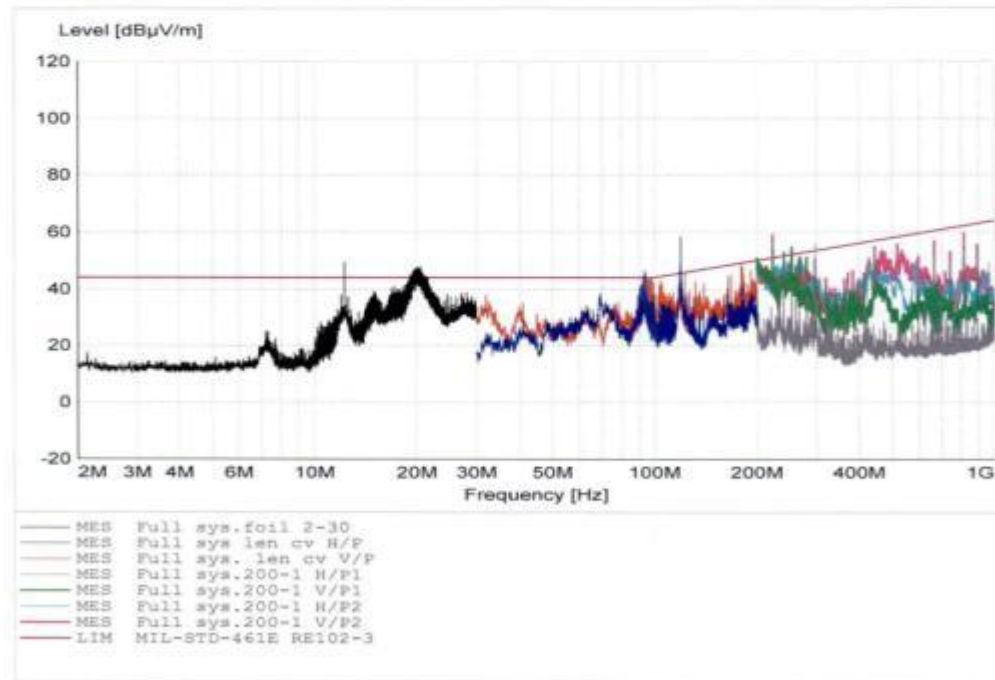
TEST DATE: 06/3-4/2011 CPAS Completely Foiled

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TEST CLASSIFICATION: Safety of Flight Battery Operated
TF.NO: W.O.NO: EV5-11-EMC-007P EMCE0-11-011
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(1) JSC: RE102 Limit (SS) w/o Shielding



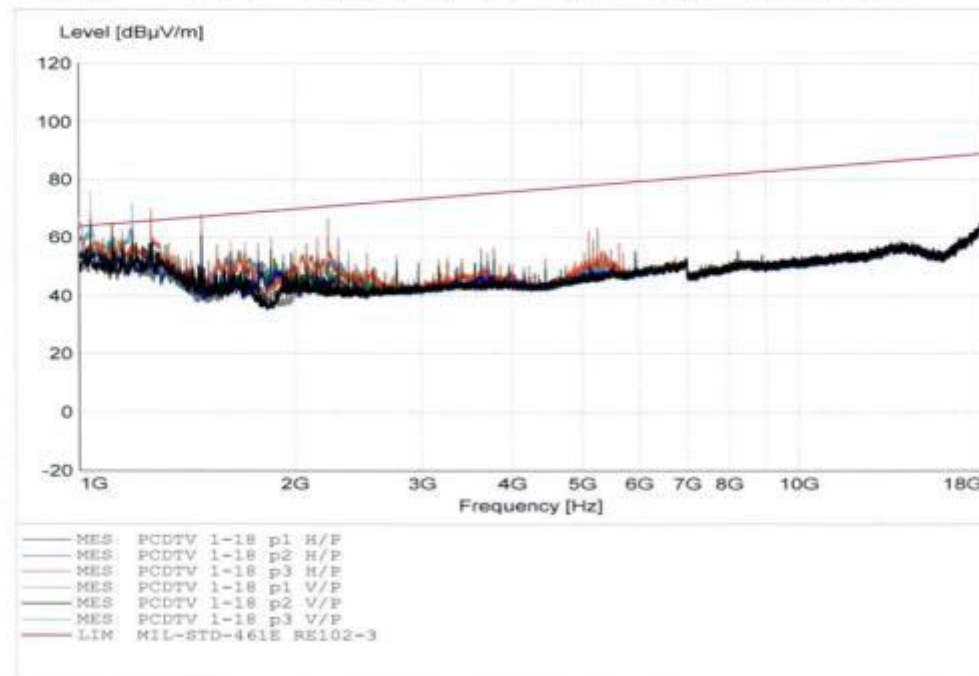
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OPERATOR: Cynthia Hightower
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Graph Colors: 3.Red 1-18GHz H/P p3 4. Gray 1-18GHz V/P p1
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(1) JSC: RE102 Limit (SS) w/ Shielding



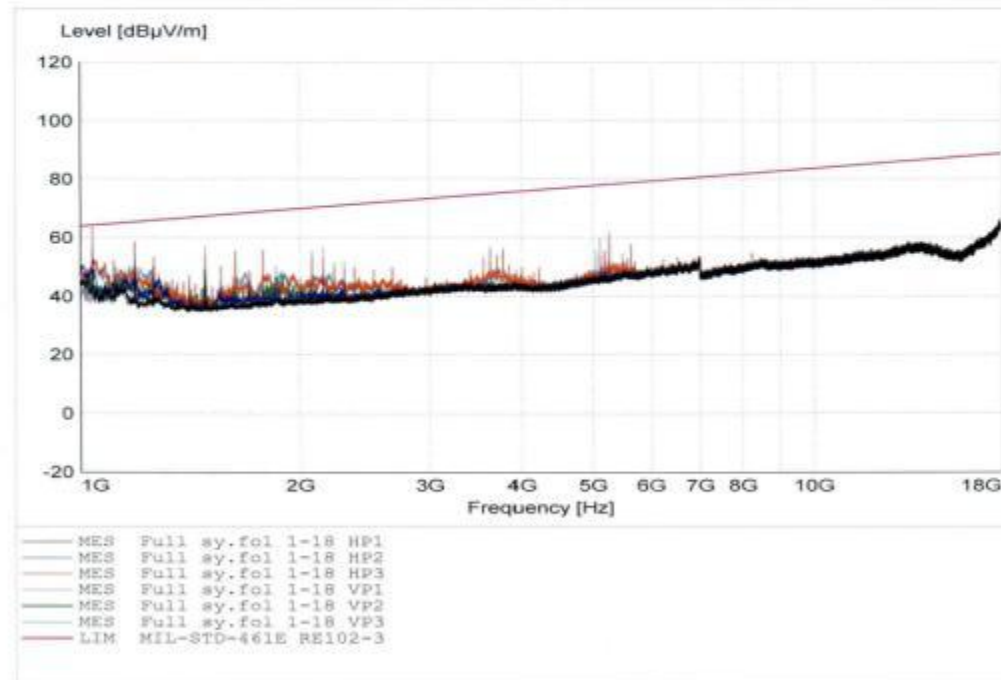
TEST DATE: 06/04/2011 CPAS Completely Foiled

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TEST CLASSIFICATION: Safety of Flight Battery Operated
TP.NO: W.O.NO: EVS-11-EMC-007P SMCE0-11-011
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Graph Colors: 5.Green 1-18GHz V/P p2 6.Lt Blue 1-18GHz V/P p3

SCAN TABLE: "MIL-STD-461E RE102"

Start	Stop	Step	Detector	Meas. Time	IF Bandw.	Transducer
Frequency	Frequency	Width				
10.0 kHz	150.0 kHz	500.0 Hz	MaxPeak	15.0 ms	1 kHz	SAS-200/550-1 686
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak	15.0 ms	10 kHz	SAS-200/550-1 686
30.0 MHz	200.0 MHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3104C 4708 4714
200.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	15.0 ms	100 kHz	3106 S/N 2824
1.0 GHz	18.0 GHz	300.0 kHz	MaxPeak	15.0 ms	1 MHz	3115 S/N 6059



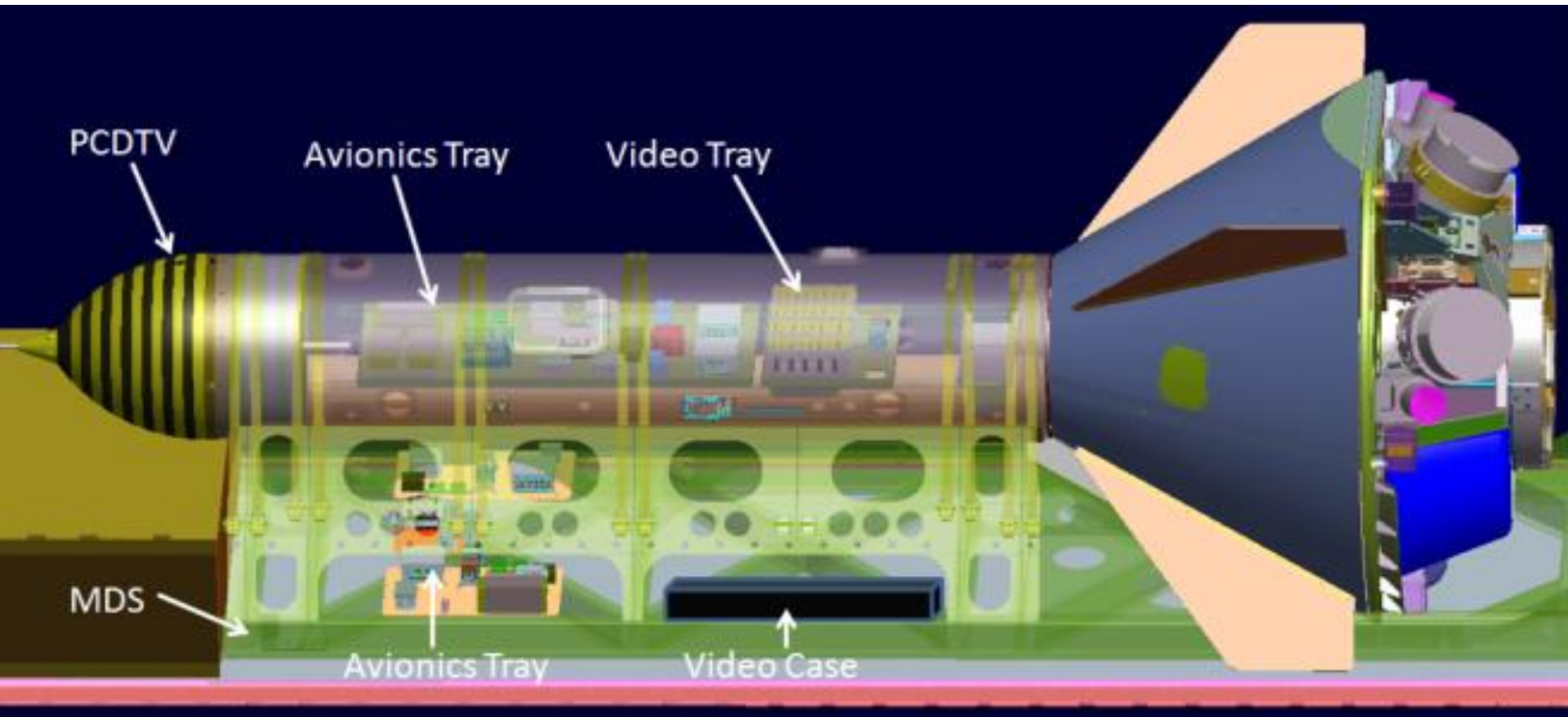


Outline



- Introduction
 - Space Exploration [NASA (New) Role/Mission]
 - (New) Space Ship ~ “Orion”
 - (Old) Space Shuttle Replacement
- **Orion Parachute Reentry ~ High-Altitude A/C Drop Tests**
 - EMI Tests
 - SoF (A/C ~ Orion Prototype)
 - RE/RI (RS/RV) ~ MIL-STDs
 - NASA/JSC-Houston(SAC)
 - (1) Components/(1m) (Un-Shielded)
 - Army/YPG-Yuma(Hanger)
 - (2) Parts Build-Up (Shielded Components/NF->1m)
 - (3) Full System Integration ~ Test Vehicle (Shielded Parts/FF->1m)
 - EMC Results
- Conclusions

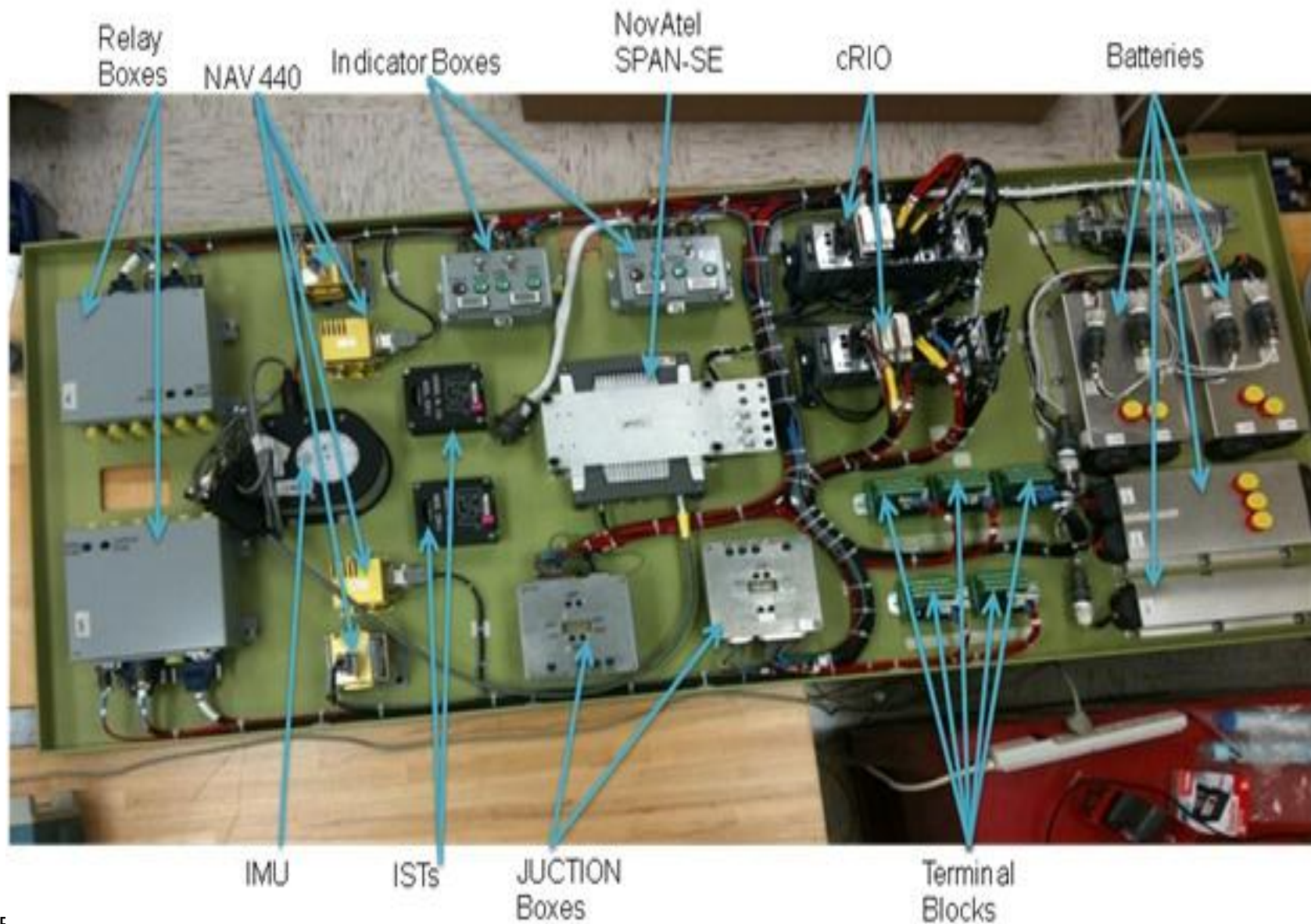
(2) YPG/DART: CPAS Sled/Tub Tests



(2) YPG/DART: DART Tube



(2) YPG/DART: Avionics Tray



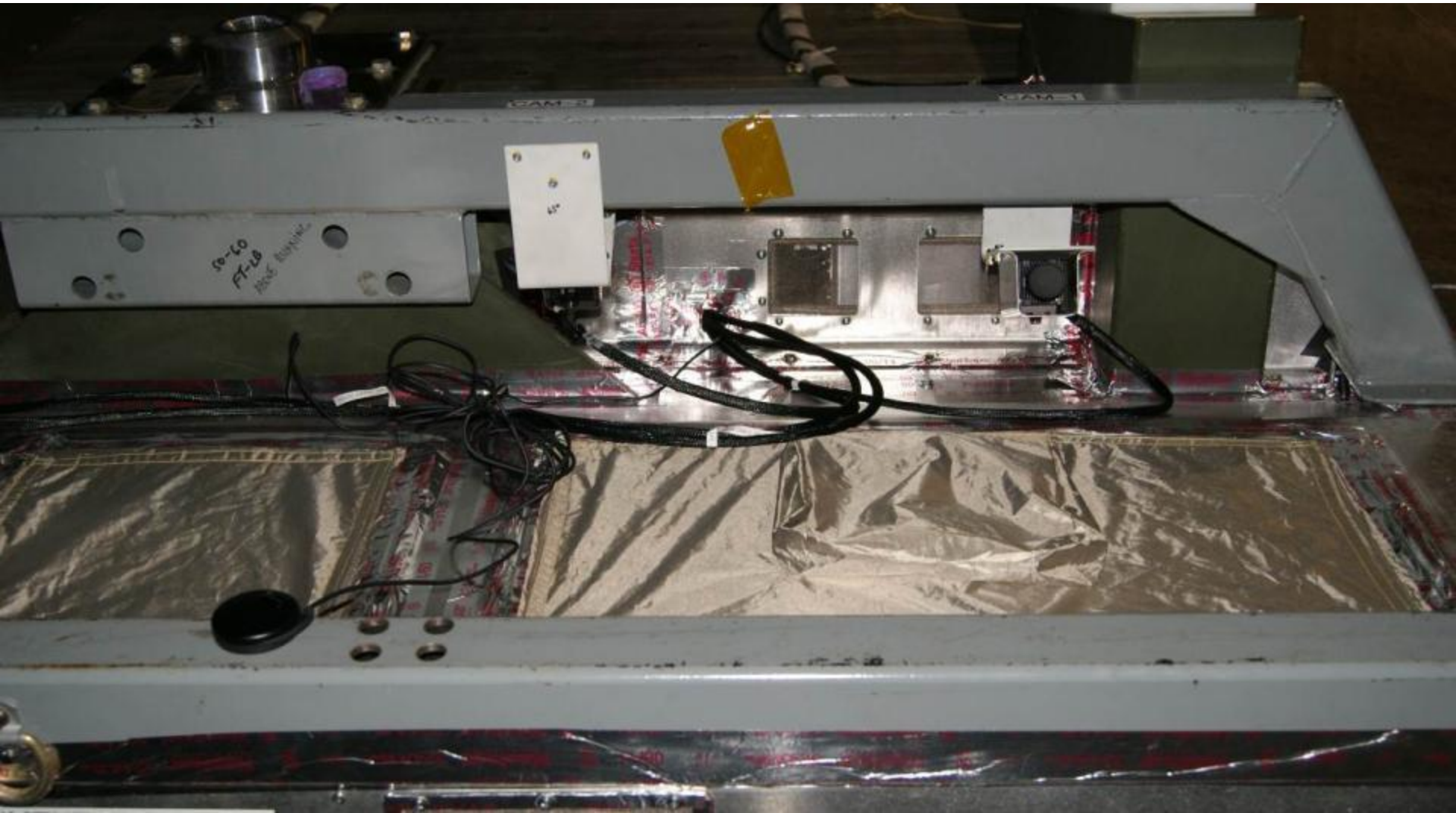


(2) YPG/DART: Avionics Tray Metal/Fabric/Mesh Shield





(2) YPG/DART: DART Integration





(2) YPG/DART: Parts Build-Up





(2) YPG/DART: DART Test/Analysis



- **Unshielded/Shielded Component Tests**
 - Apertures (Excitations)
 - B-Dot Probe
 - Spectrum Analyzer
- **Analysis**
 - Antenna Factor
 - Power ~ Voltage/Current (50 Ohms)
 - Electric Field
 - Magnetic Loop Antenna (Electrically Small)
 - Aperture (Uniform)
 - Waveguide ~ Dominant Mode (TE₁₀/TE₁₁)
 - Extrapolate (NF->1m)
 - Near Field
 - Far Field



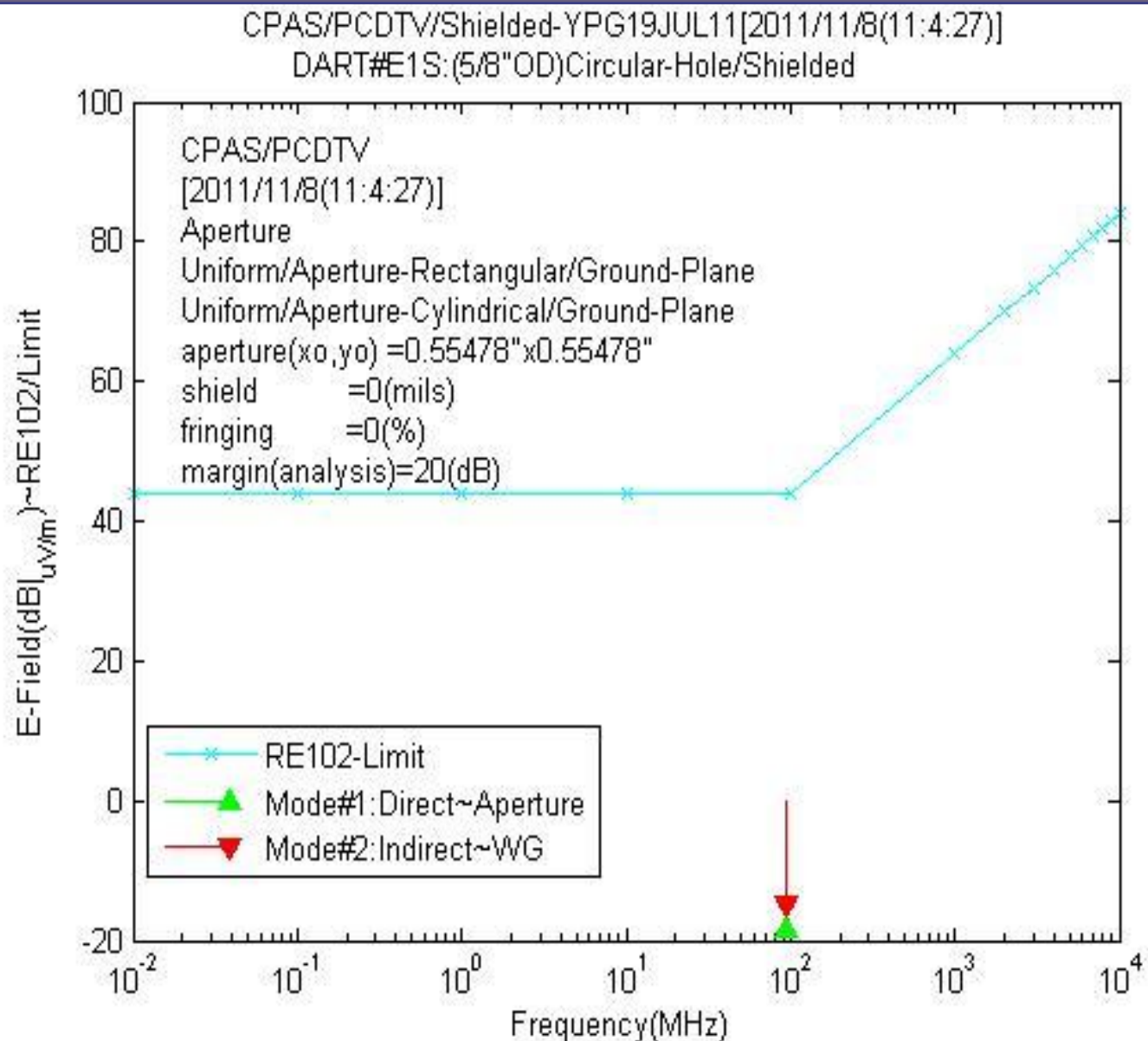
(2) YPG/DART: DART Test/Analysis



- **Equipment**
 - PCDTV Tray (Shielded)
 - MDS Tray (Unshielded/Shielded)
 - Instrumentation Tray (Unshielded/Shielded)
 - A/C Tray
 - Video Tray (Unshielded/Shielded)
 - Cameras (Unshielded)
- **Measurements**
 - Discrete Spectrum
 - SNR
 - Ambient Background Noise Floor
 - Reference Level

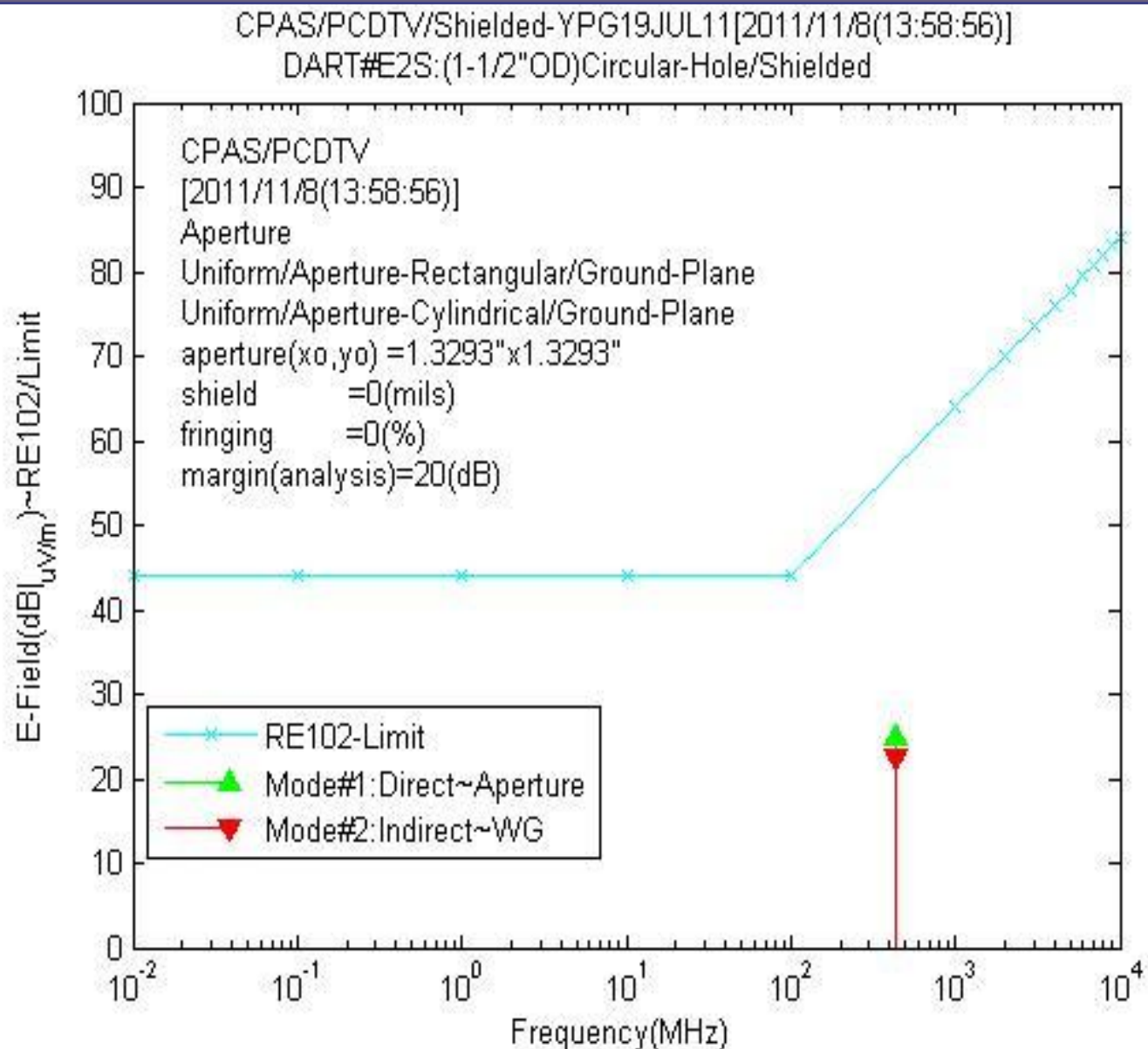


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



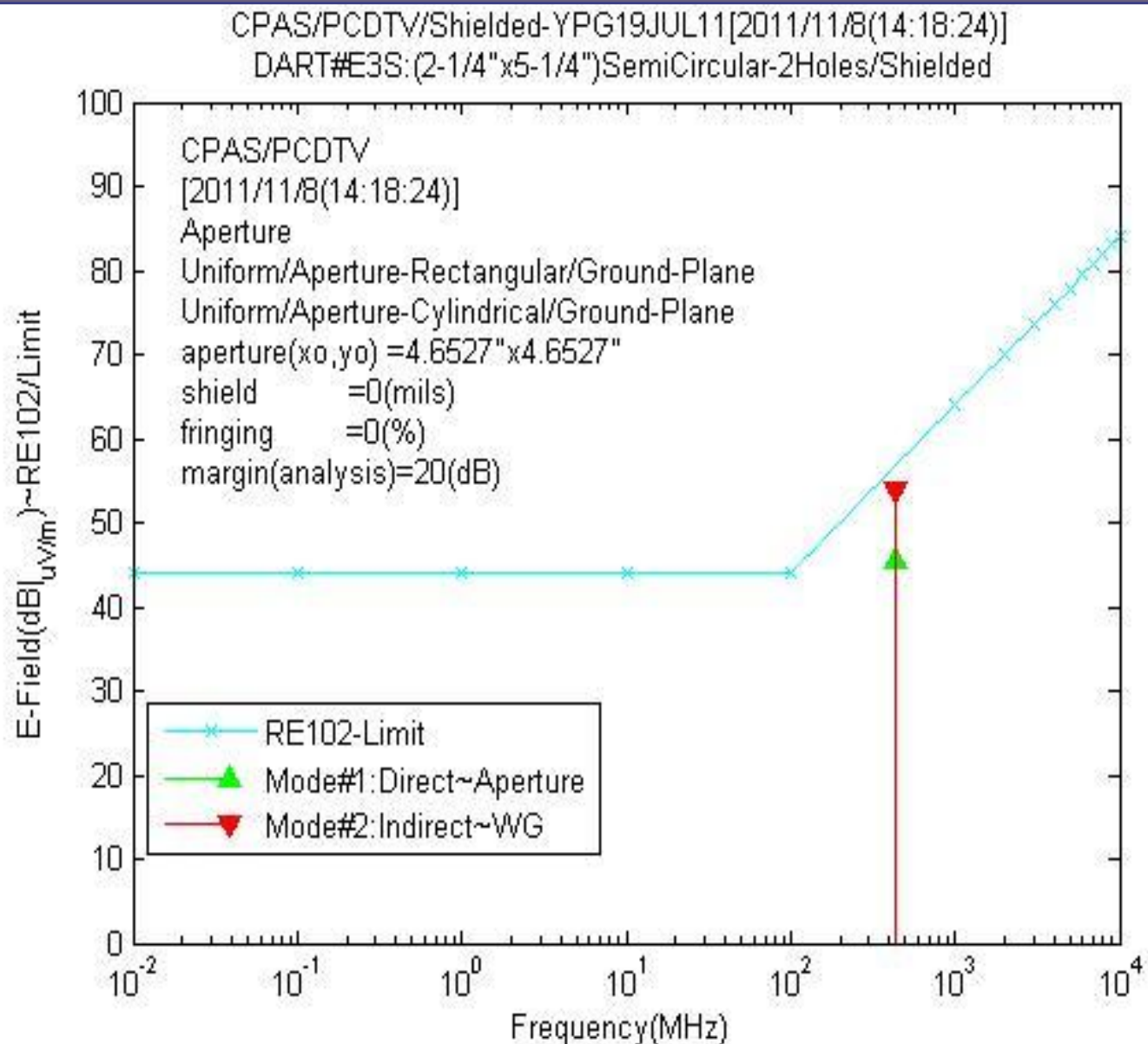


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



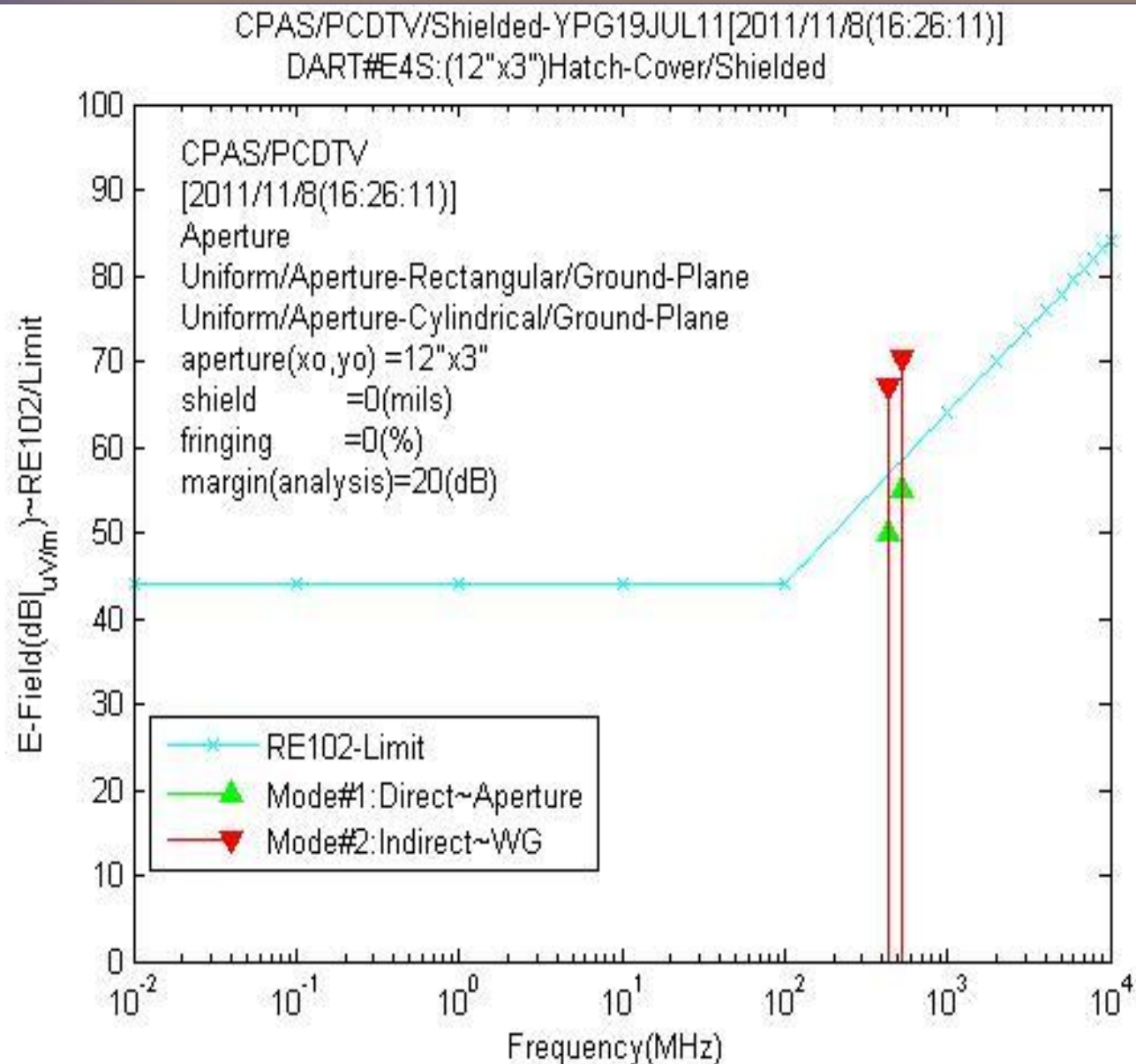


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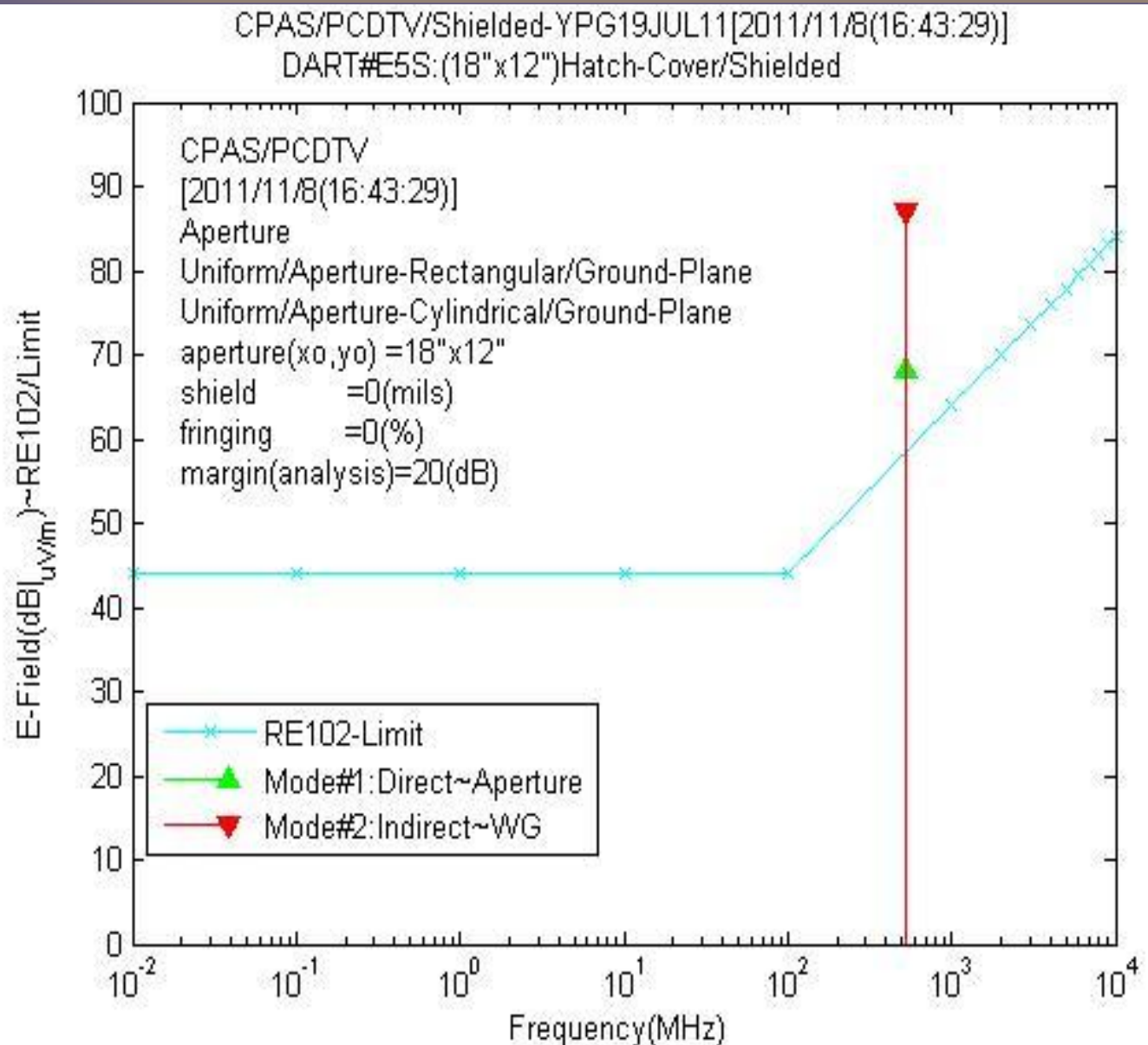


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



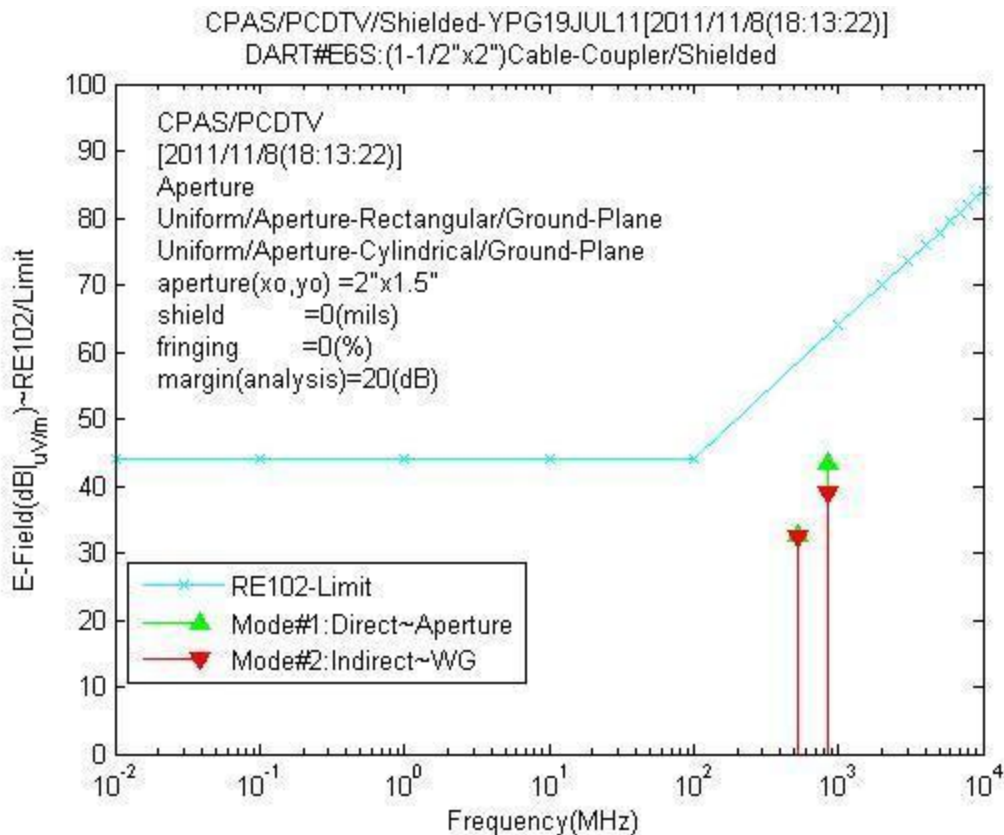


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



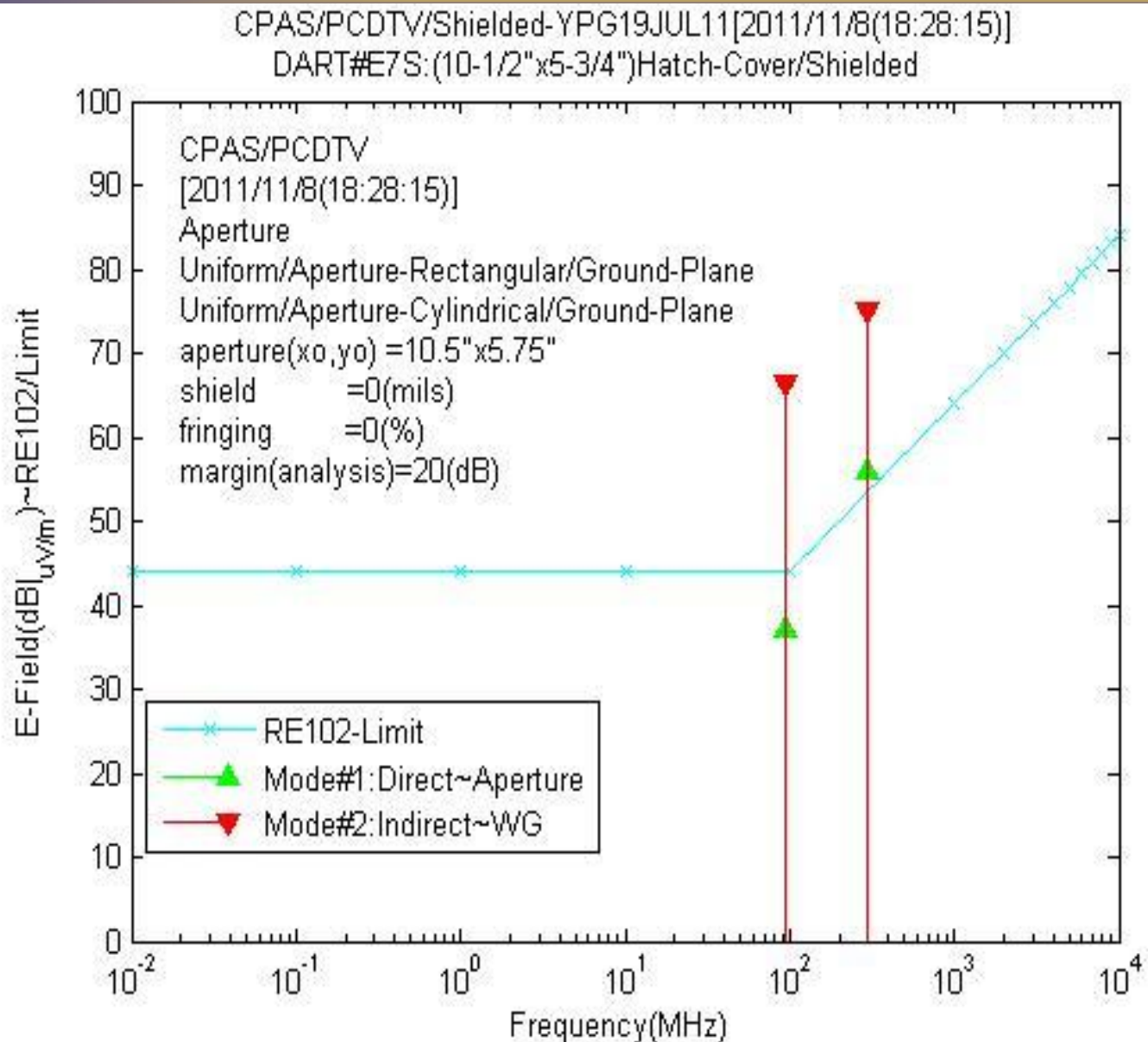


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



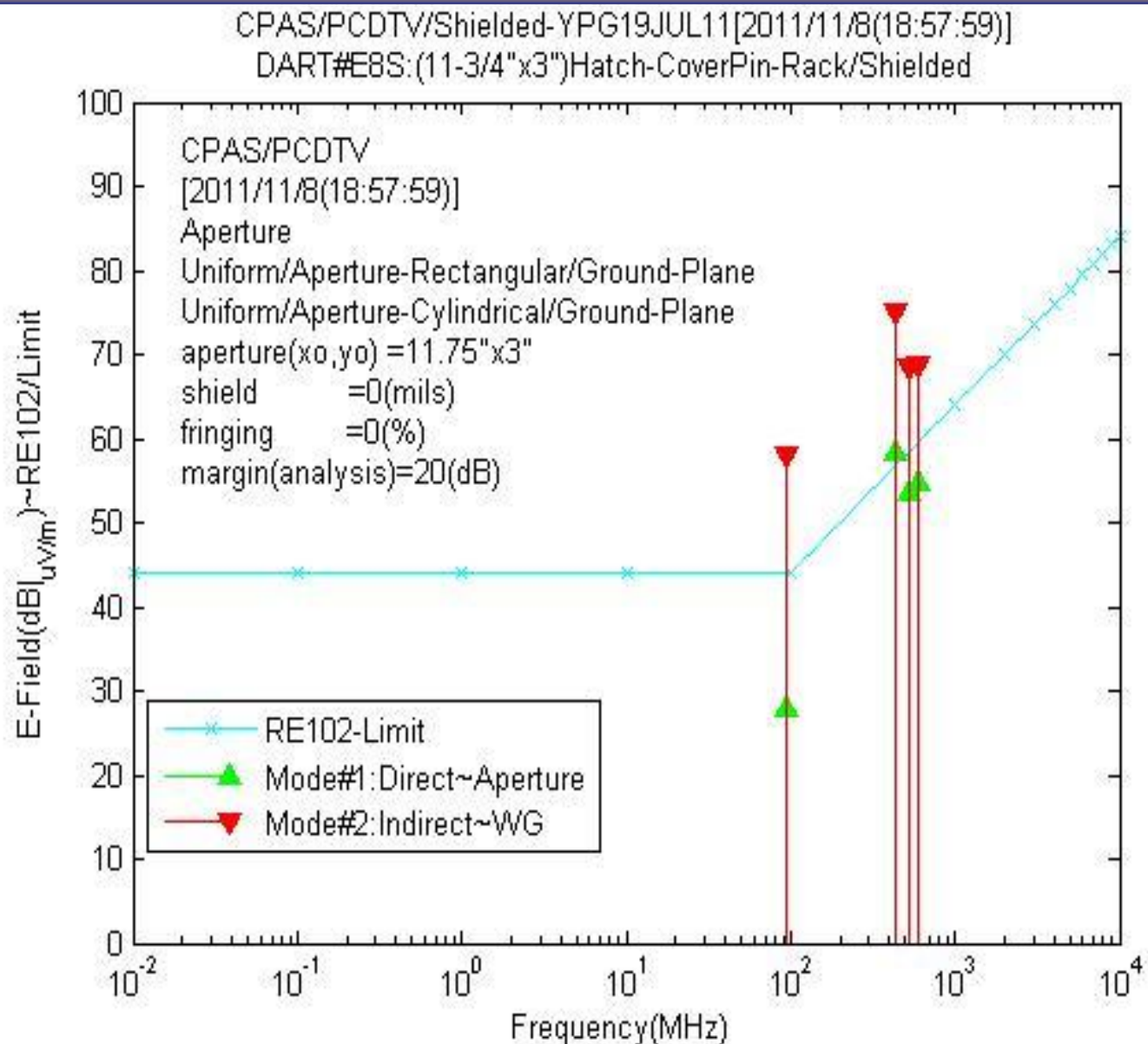


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



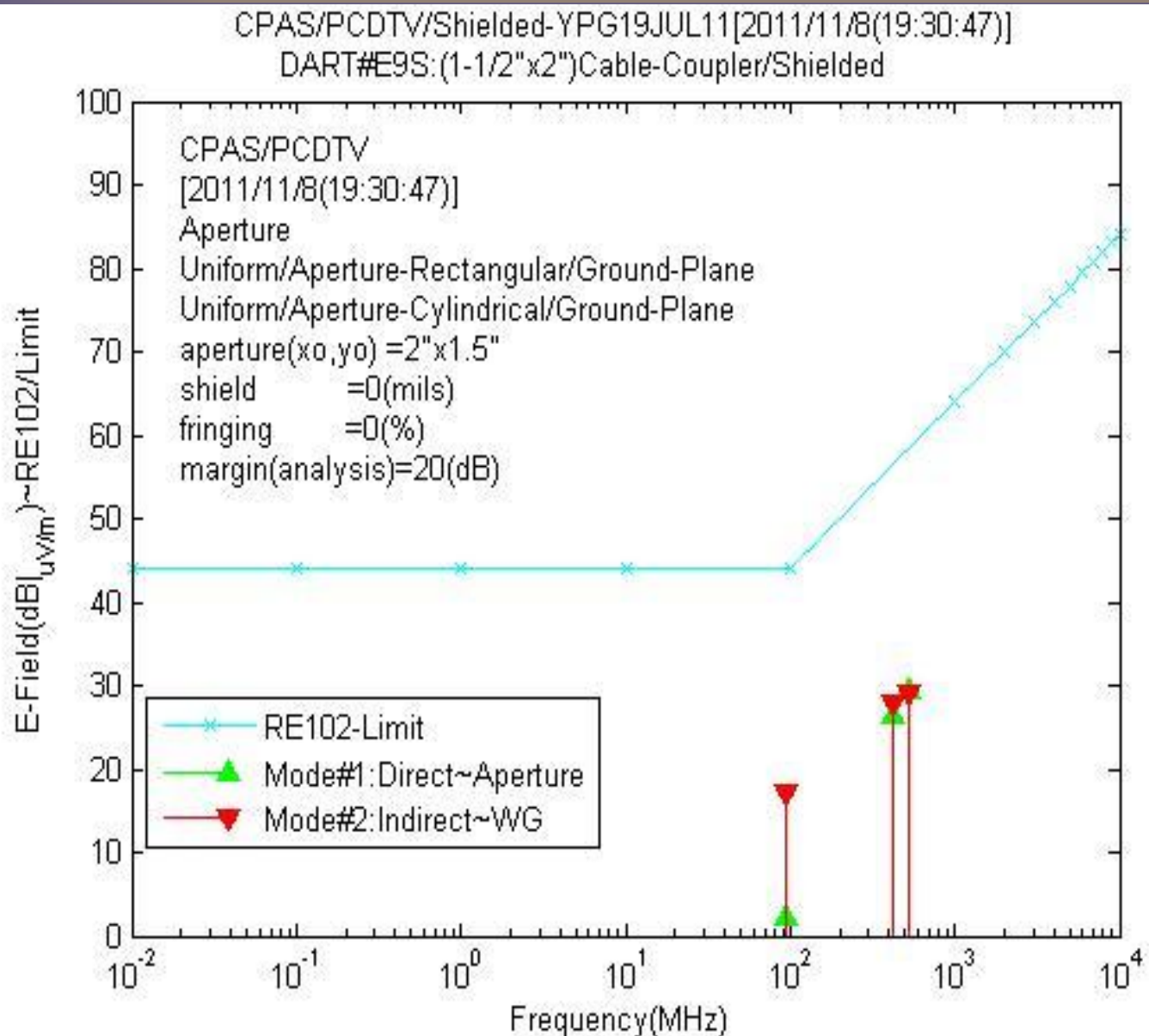


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



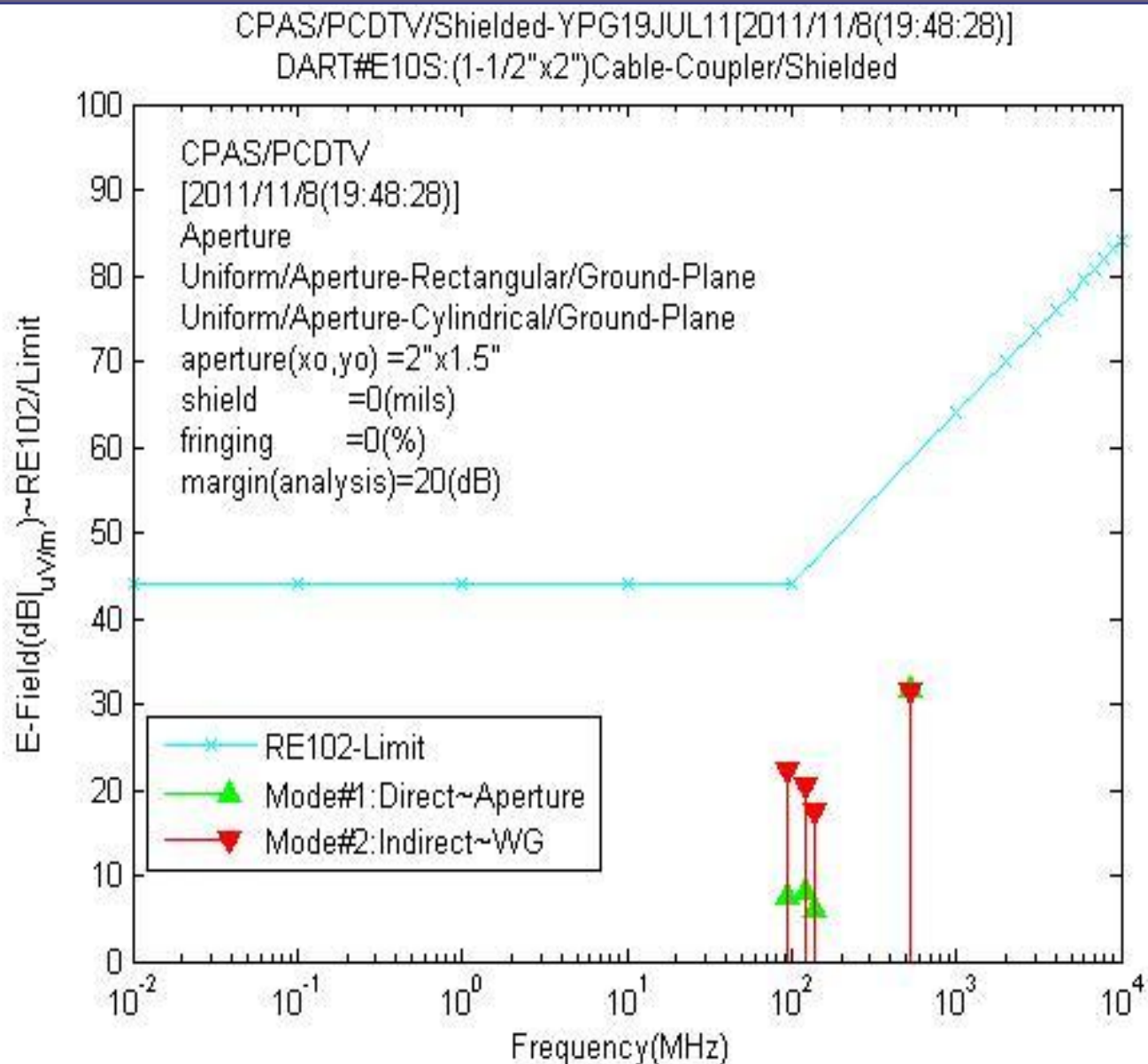


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



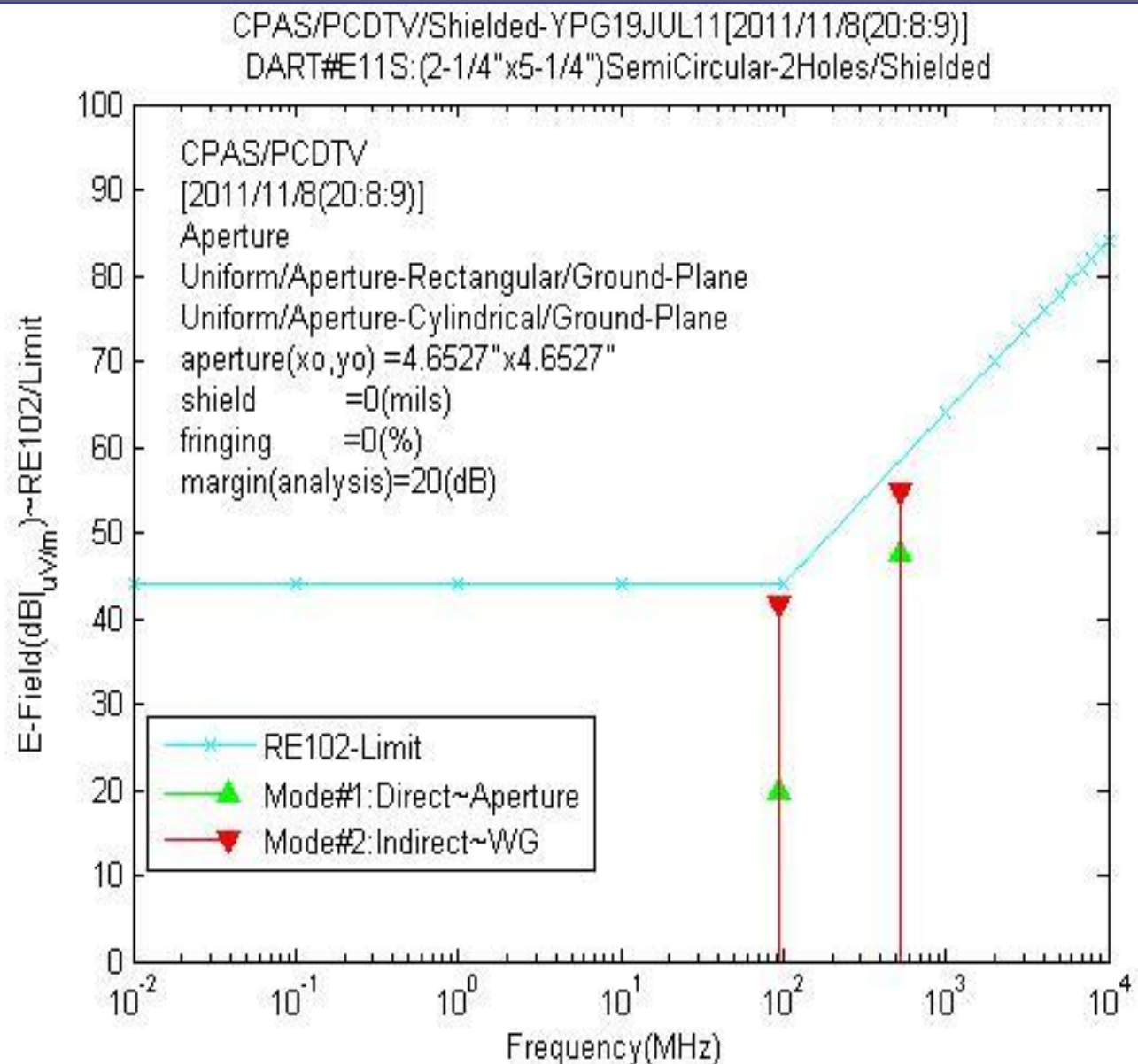


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded





(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



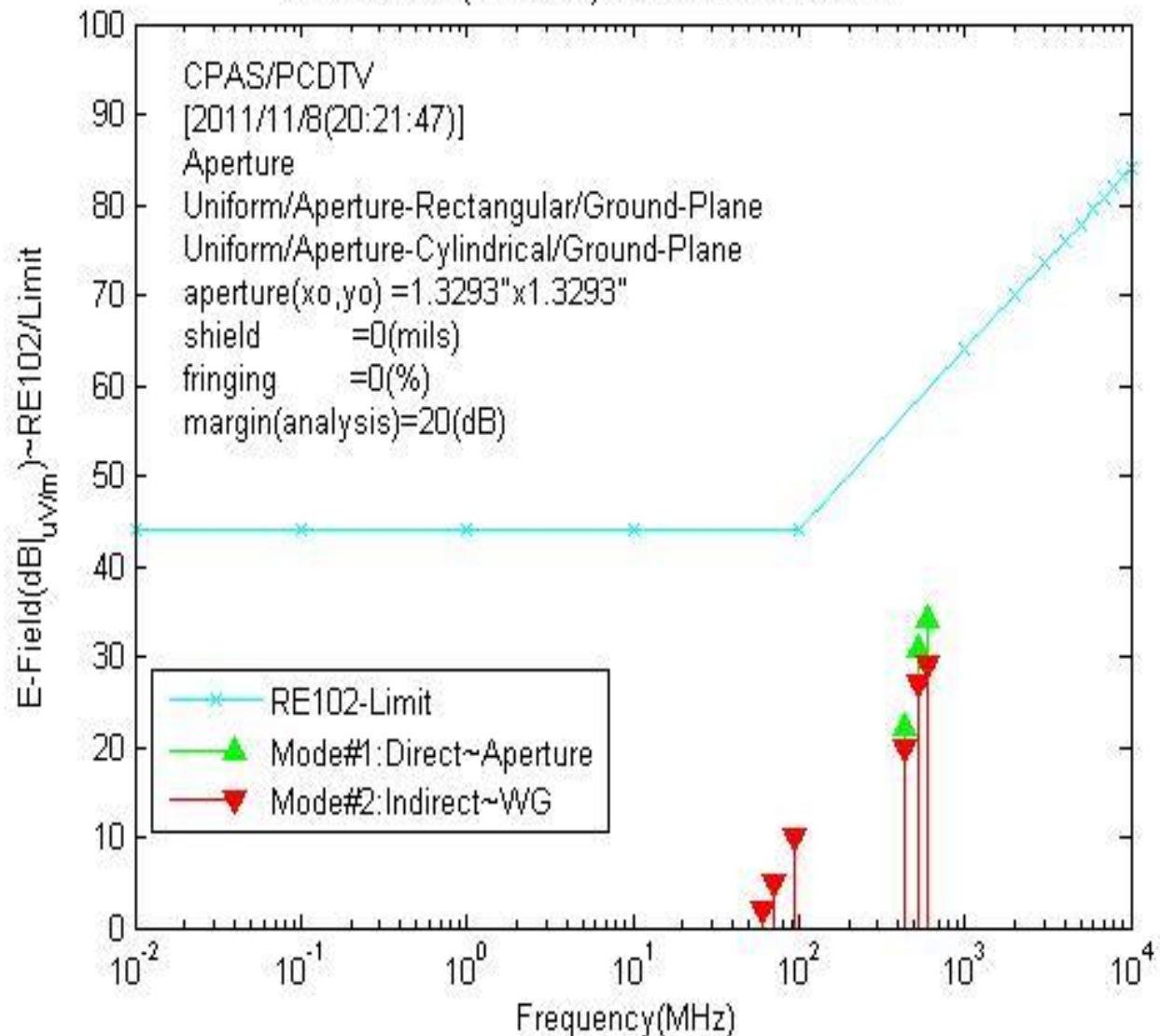


(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



CPAS/PCDTV/Shielded-YPG19JUL11[2011/11/8(20:21:47)]

DART#E12S:(1-1/2"OD)Circular-Hole/Shielded





(2) YPG/DART: CPAS/PCDTV B-Dot Probe ~ Aperture Shielded



“Starboard” Side Apertures

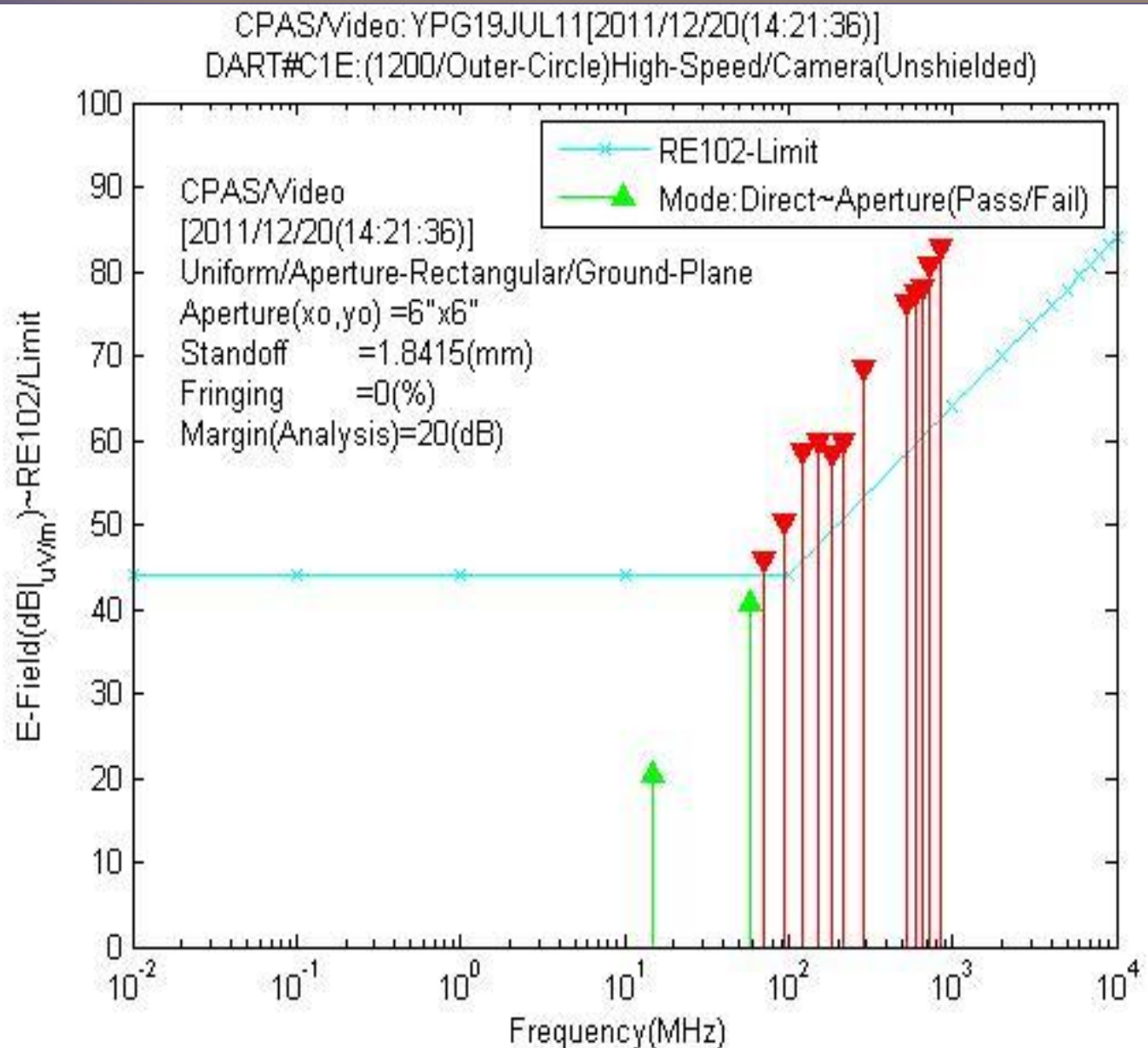
<i>Number</i>	<i>Description</i>	<i>RE102 Results</i>
DART E1S	(5/8"OD)Circular-Hole/Shielded	Pass/Pass
DART E2S	(1-1/2"OD)Circular-Hole/Shielded	Pass/Pass
DART E3S	(2-1/4"x5-1/4")SemiCircular-2Holes/Shielded	Pass/Pass
DART E4S	(12"x3")Hatch-Cover/Shielded	Pass/Fail
DART E5S	(18"x12")Hatch-Cover/Shielded	Fail /Fail
DART E6S	(1-1/2"x2")Cable-Coupler/Shielded	Pass/Pass
DART E7S	(10-1/2"x5-3/4")Hatch-Cover/Shielded	Fail /Fail
DART E8S	(11-3/4"x3")Hatch-Cover/Pin-Rack/Shielded	Fail /Fail
DART E9S	(1-1/2"x2")Cable-Coupler/Shielded	Pass/Pass
DART E10S	(1-1/2"x2")Cable-Coupler/Shielded	Pass/Pass
DART E11S	(2-1/4"x5-1/4")SemiCircular-2Holes/Shielded	Pass/Pass
DART E12S	(1-1/2"OD)Circular-Hole/Shielded	Pass/Pass

“Port” Side Apertures

<i>Number</i>	<i>Description</i>	<i>RE102 Results</i>
DART W1S	(1-1/2"OD)Circular-Hole/Shielded	Pass/Pass
DART W2S	(2-1/4"x5-1/4")SemiCircular-2Holes/Shielded	Pass/Pass
DART W3S	(10"x10")Hatch-Cover/Shielded	Fail/Fail
DART W4S	(12"x3")Hatch-Cover/Pin-Rack/Shielded	Pass/Fail
DART W5S	(3"OD)Circular-Hole/Shielded	Pass/Pass
DART W6S	(2-1/4"x5-1/4")SemiCircular-2Holes/Shielded	Pass/Pass
DART W7S	(1-1/2"OD)Circular-Hole/Shielded	Pass/Pass

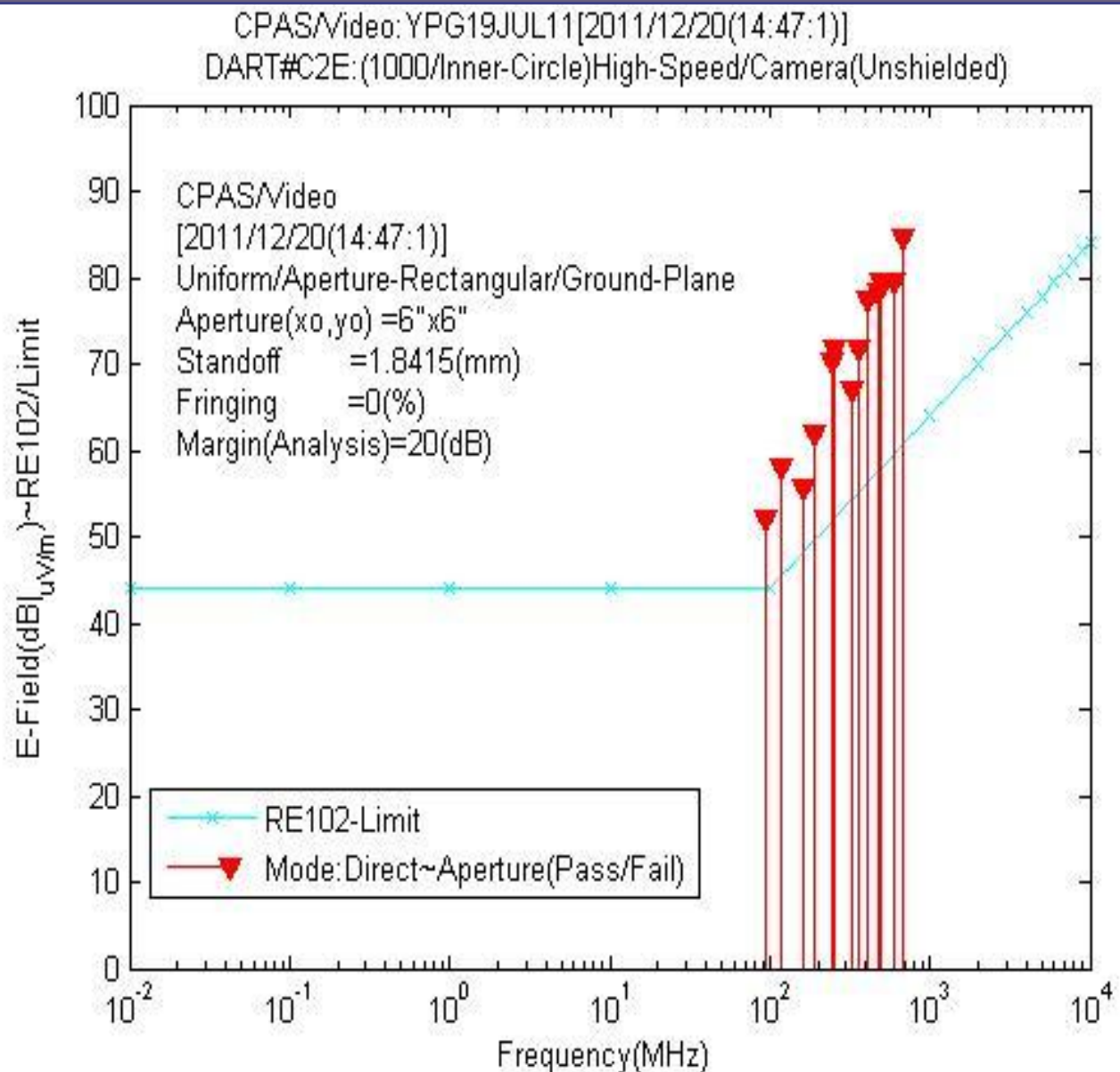


(2) YPG/DART: CPAS/Video Cameras B-Dot Probe ~ Aperture Shielded



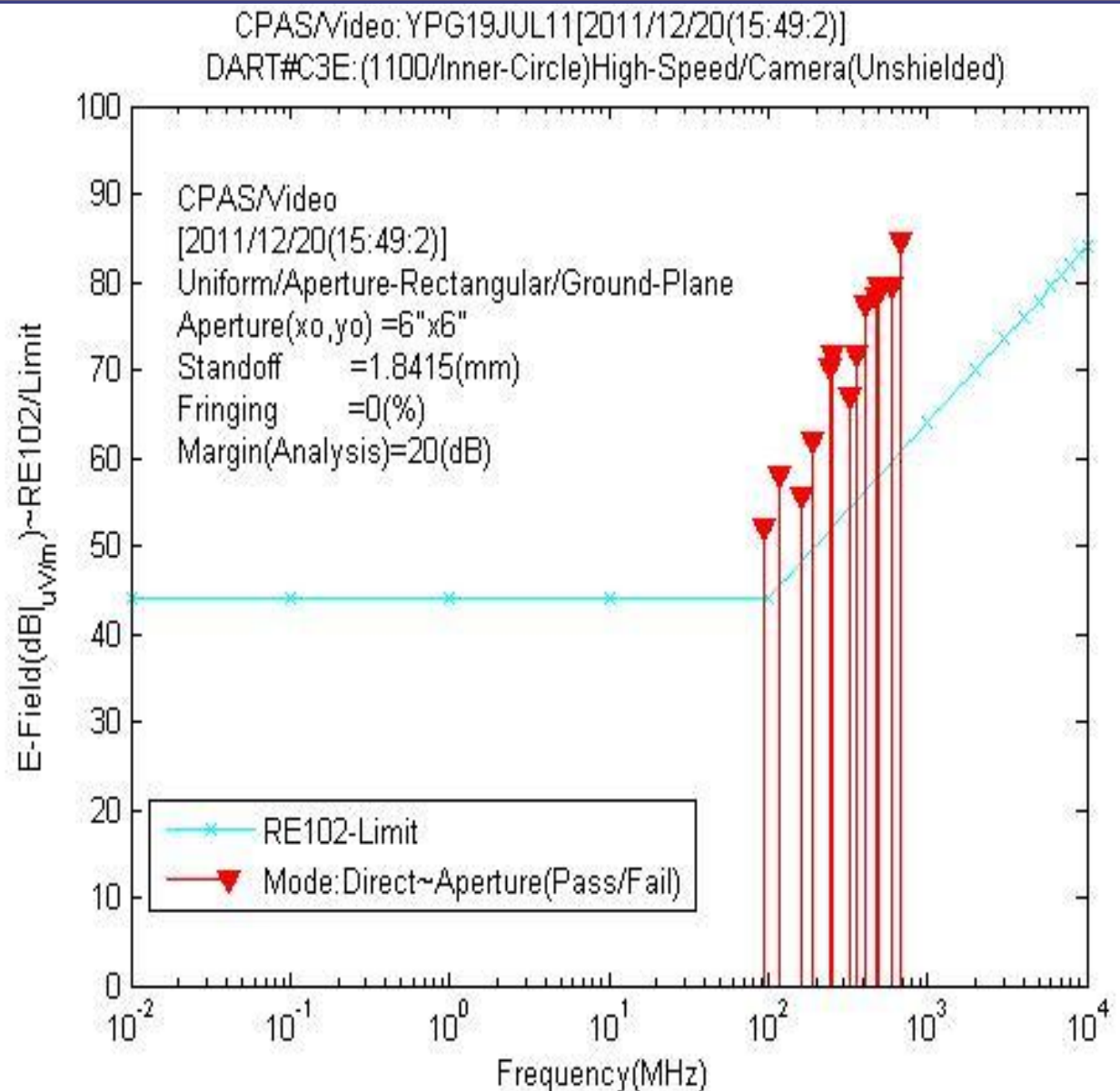


(2) YPG/DART: CPAS/Video Cameras B-Dot Probe ~ Aperture Shielded



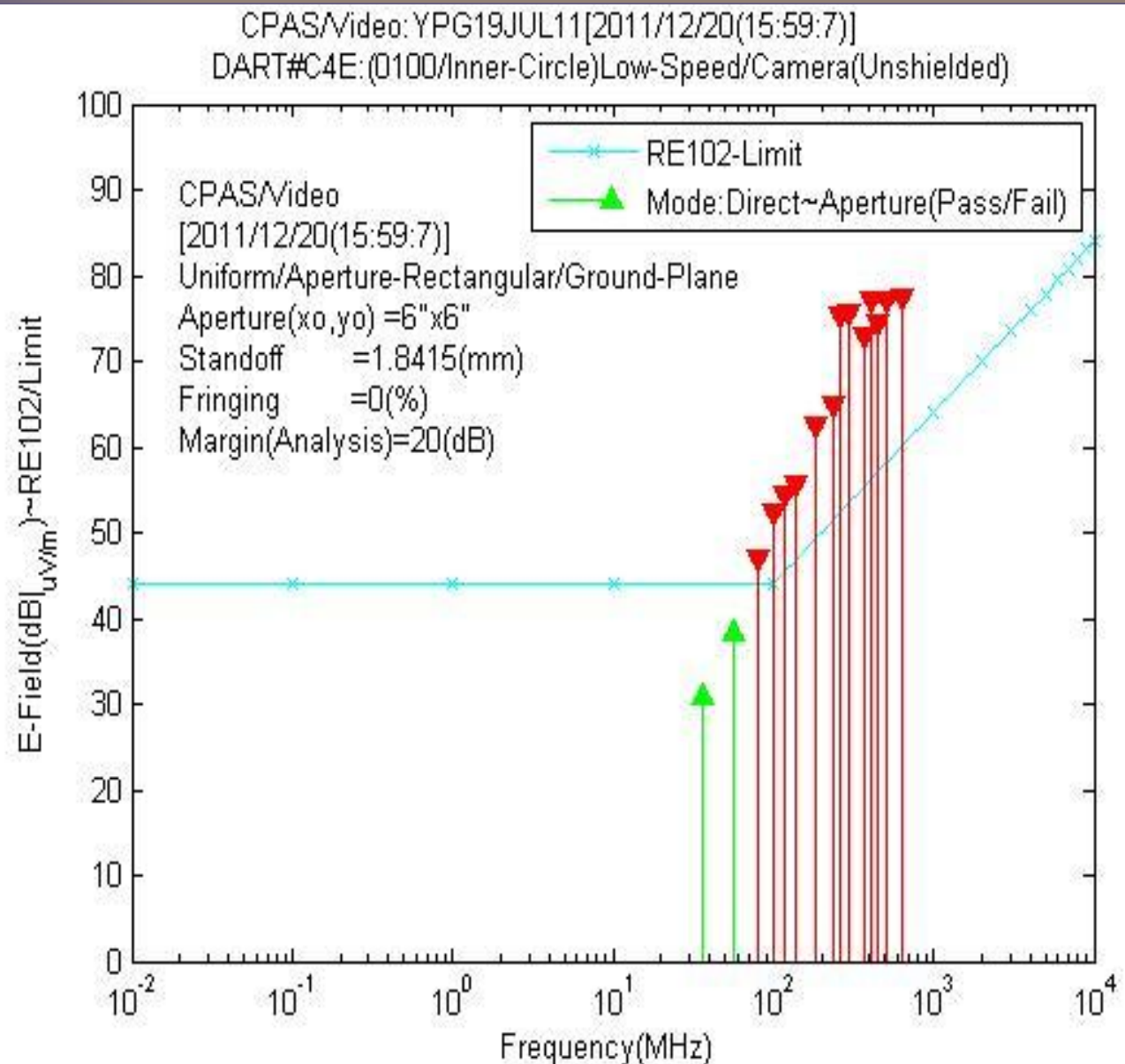


(2) YPG/DART: CPAS/Video Cameras B-Dot Probe ~ Aperture Shielded



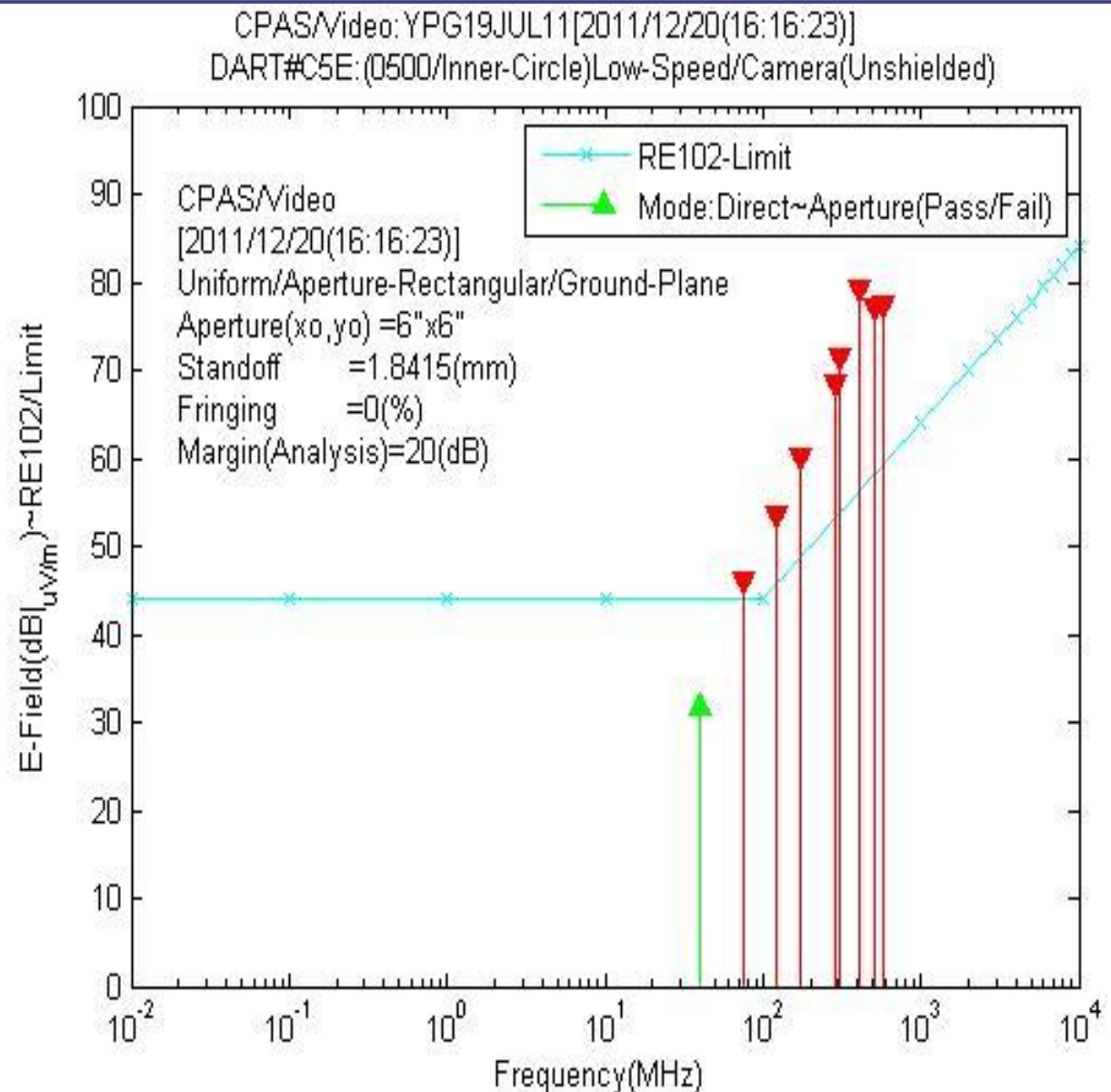


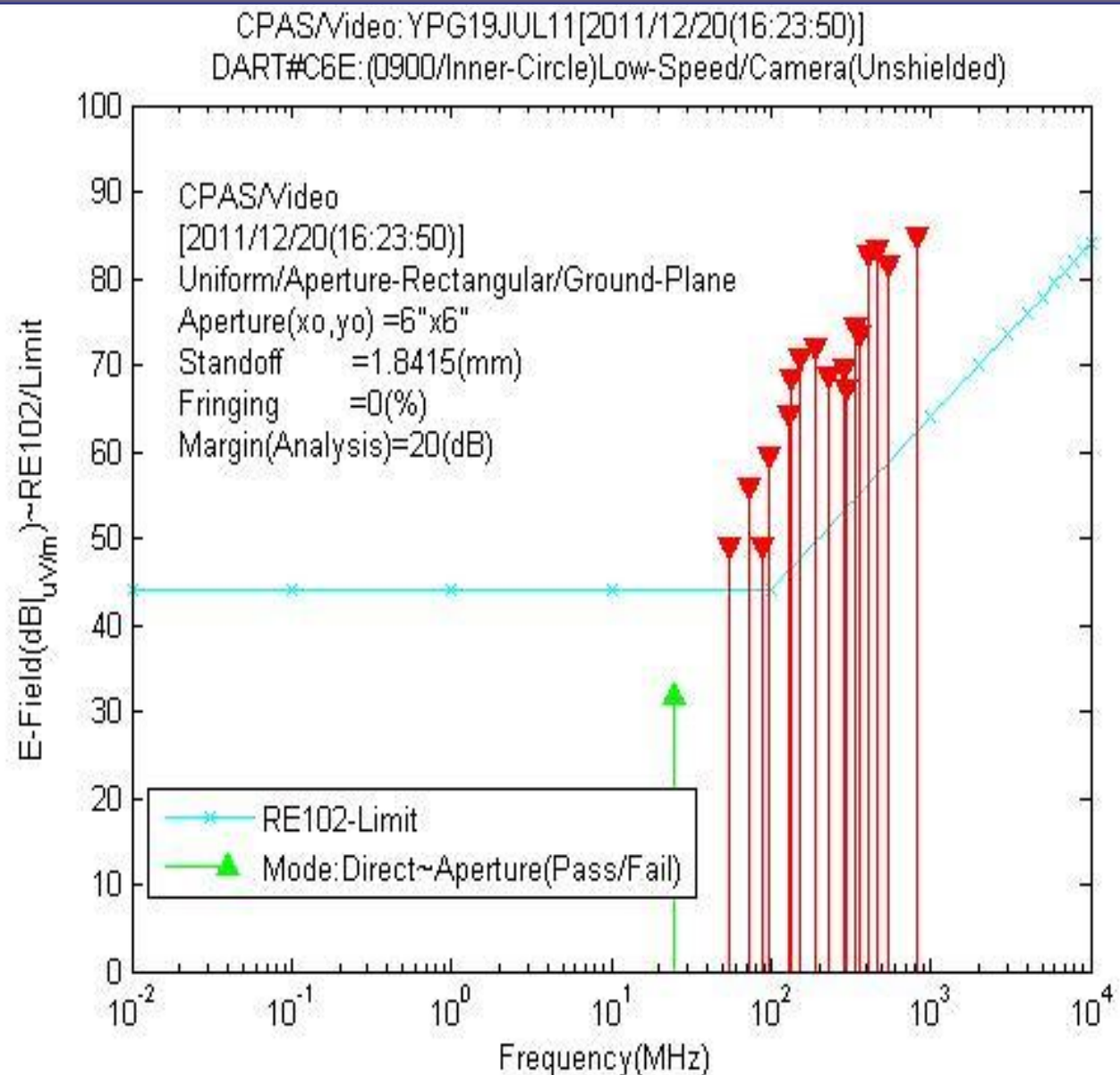
(2) YPG/DART: CPAS/Video Cameras B-Dot Probe ~ Aperture Shielded





(2) YPG/DART: CPAS/Video Cameras B-Dot Probe ~ Aperture Shielded





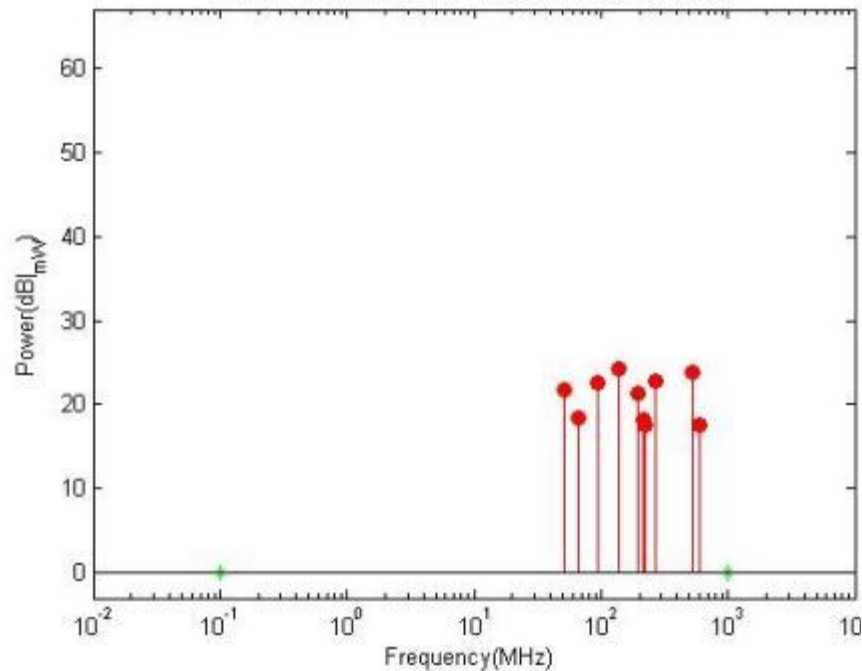
Video-Cameras AFT/“North” Side Apertures		
Number	Description	RE102 Results
DART C1E	(6”x6”)(1200/Outer-Ring)High-Speed (Unshielded)	Fail
DART C2E	(6”x6”)(1000/Inner-Ring)High-Speed (Unshielded)	Fail
DART C3E	(6”x6”)(1100/Inner-Ring)High-Speed (Unshielded)	Fail
DART C4E	(6”x6”)(0100/Inner-Ring)Low-Speed (Unshielded)	Fail
DART C5E	(6”x6”)(0500/Inner-Ring)Low-Speed (Unshielded)	Fail
DART C6E	(6”x6”)(0900/Inner-Ring)Low-Speed (Unshielded)	Fail



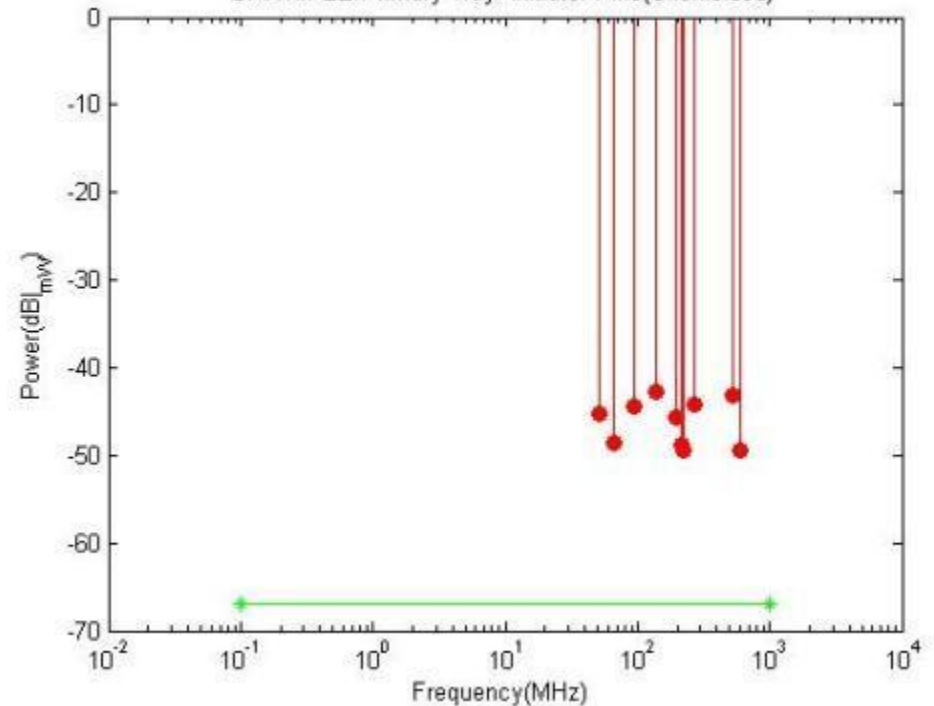
(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



CPAS/MDS: YPG25JUL11[2011/12/19(15:20:40)]
DART#P2E: Primary-Tray~Initiator-Pins(Unshielded)

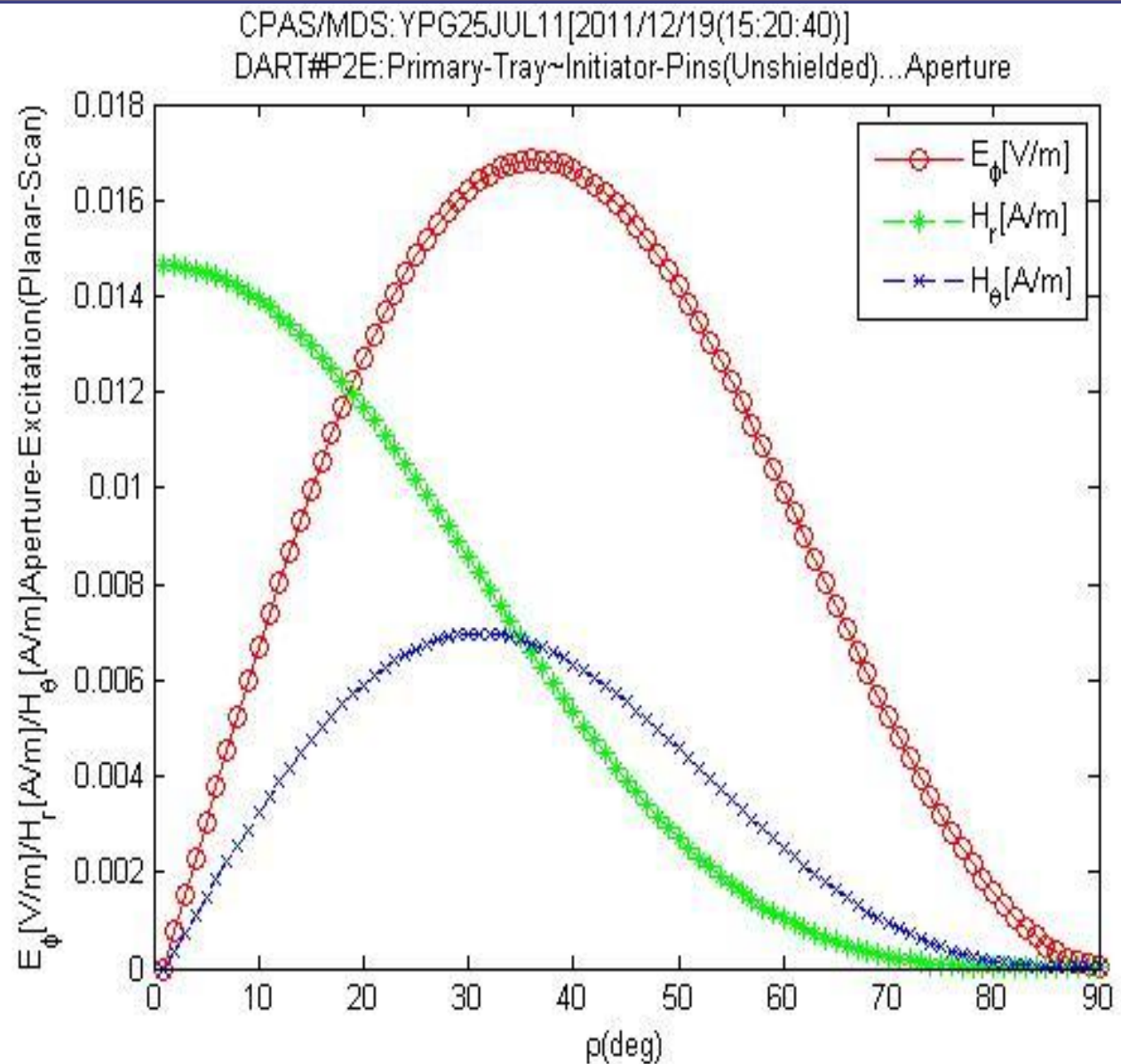


CPAS/MDS: YPG25JUL11[2011/12/19(15:20:40)]
DART#P2E: Primary-Tray~Initiator-Pins(Unshielded)





(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded

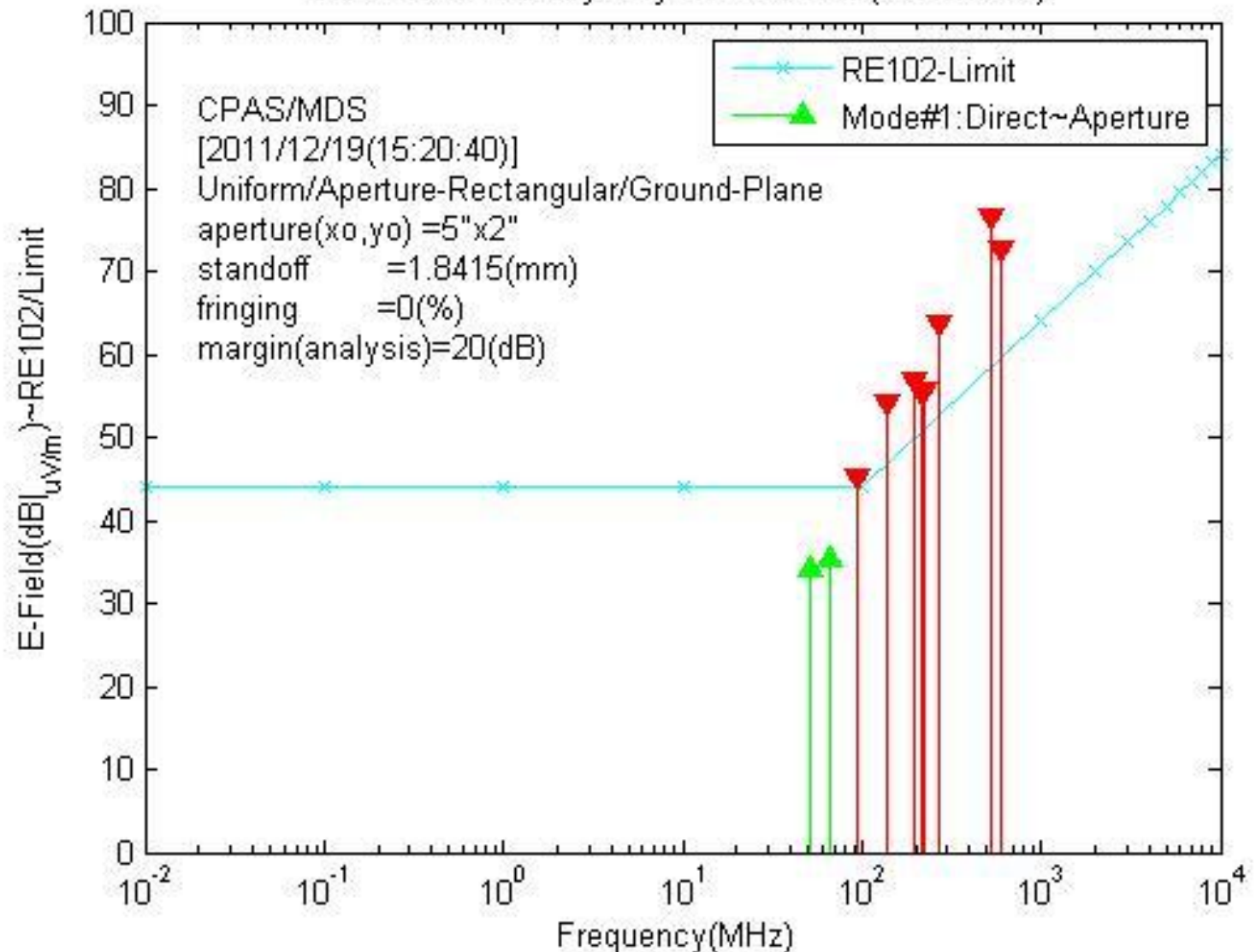




(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded

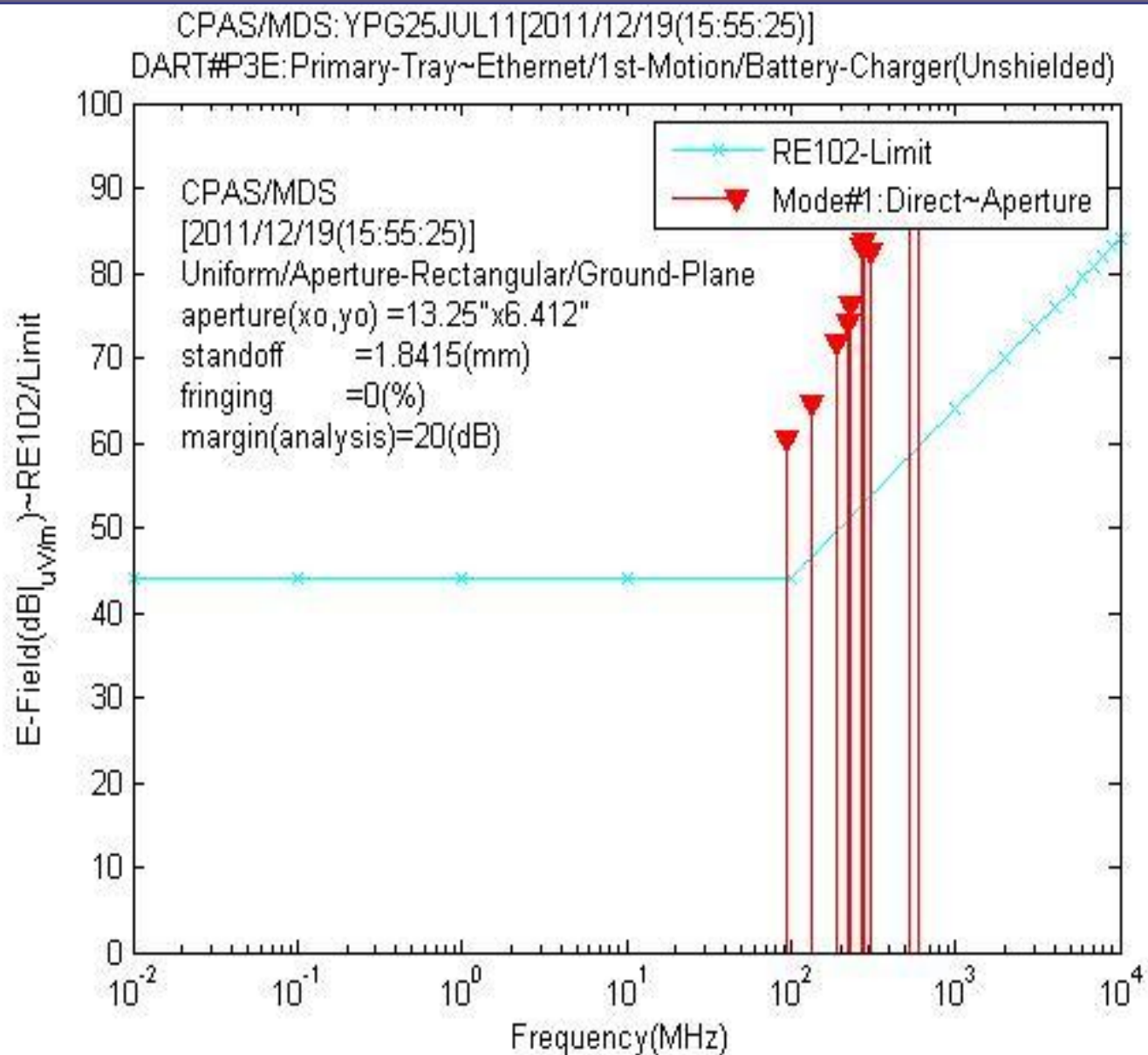


CPAS/MDS: YPG25JUL11[2011/12/19(15:20:40)]
DART#P2E:Primary-Tray~Initiator-Pins(Unshielded)





(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



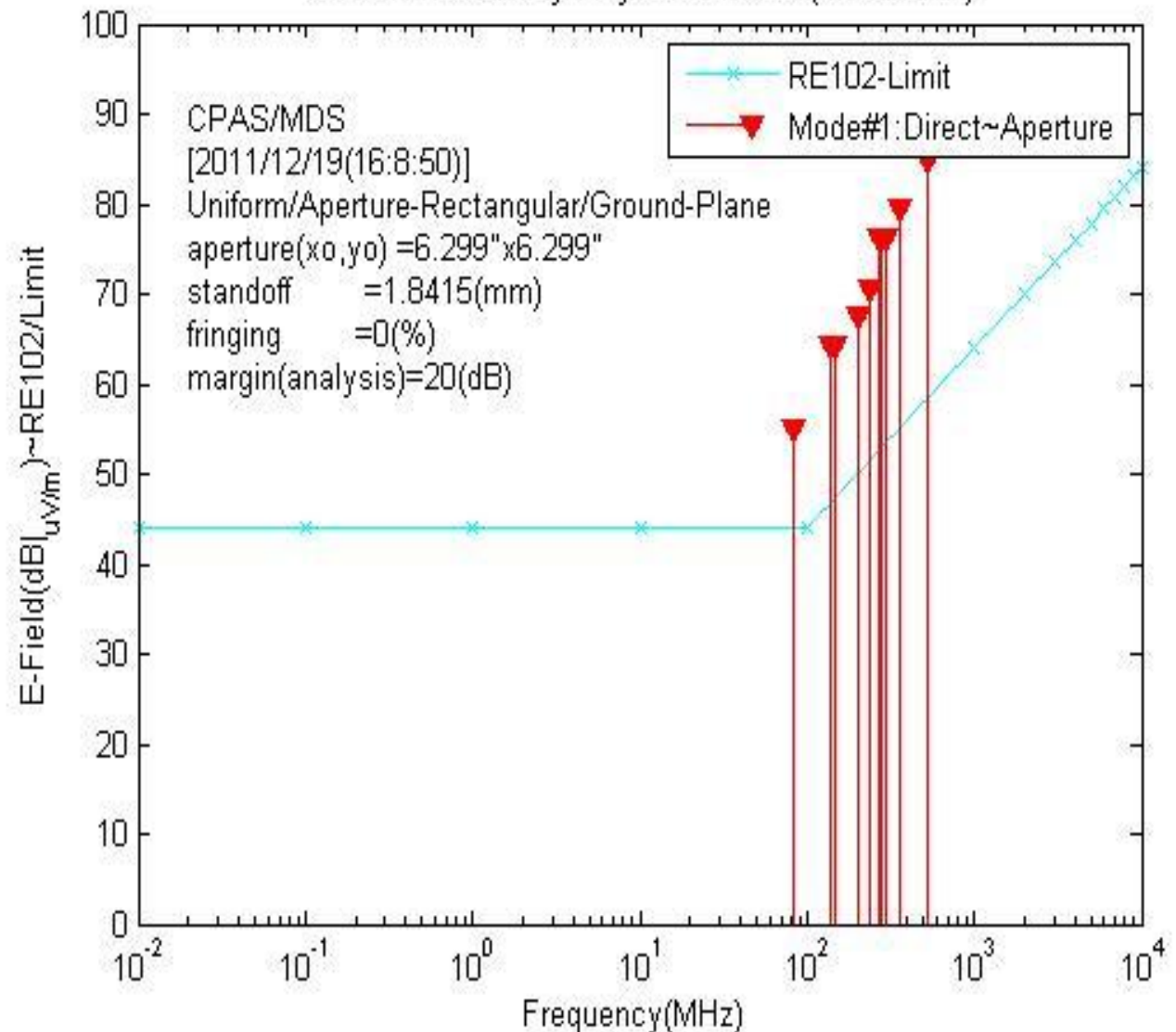


(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



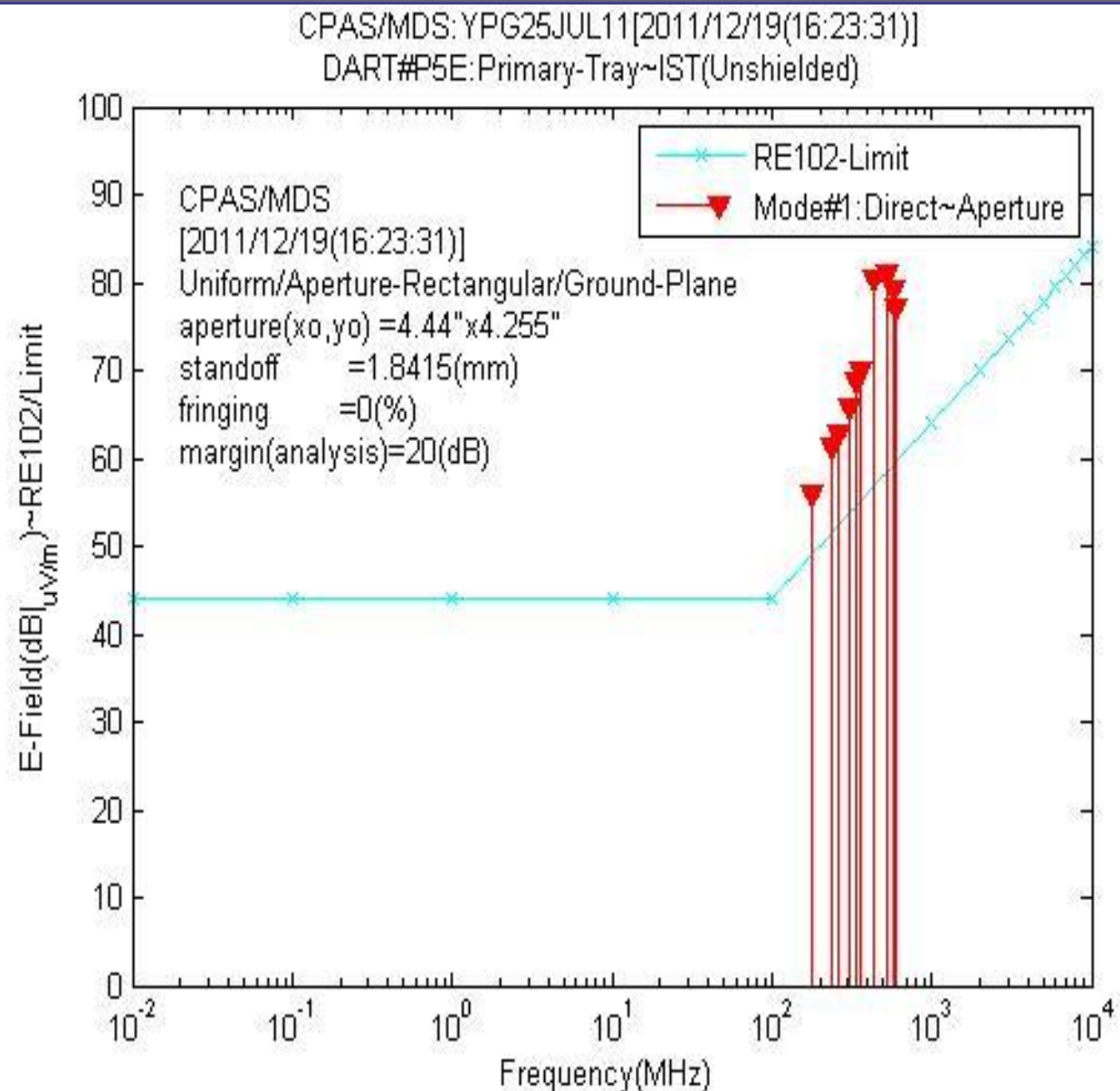
CPAS/MDS: YPG25JUL11[2011/12/19(16:8:50)]

DART#P4E: Primary-Tray~Juntion-Box(Unshielded)



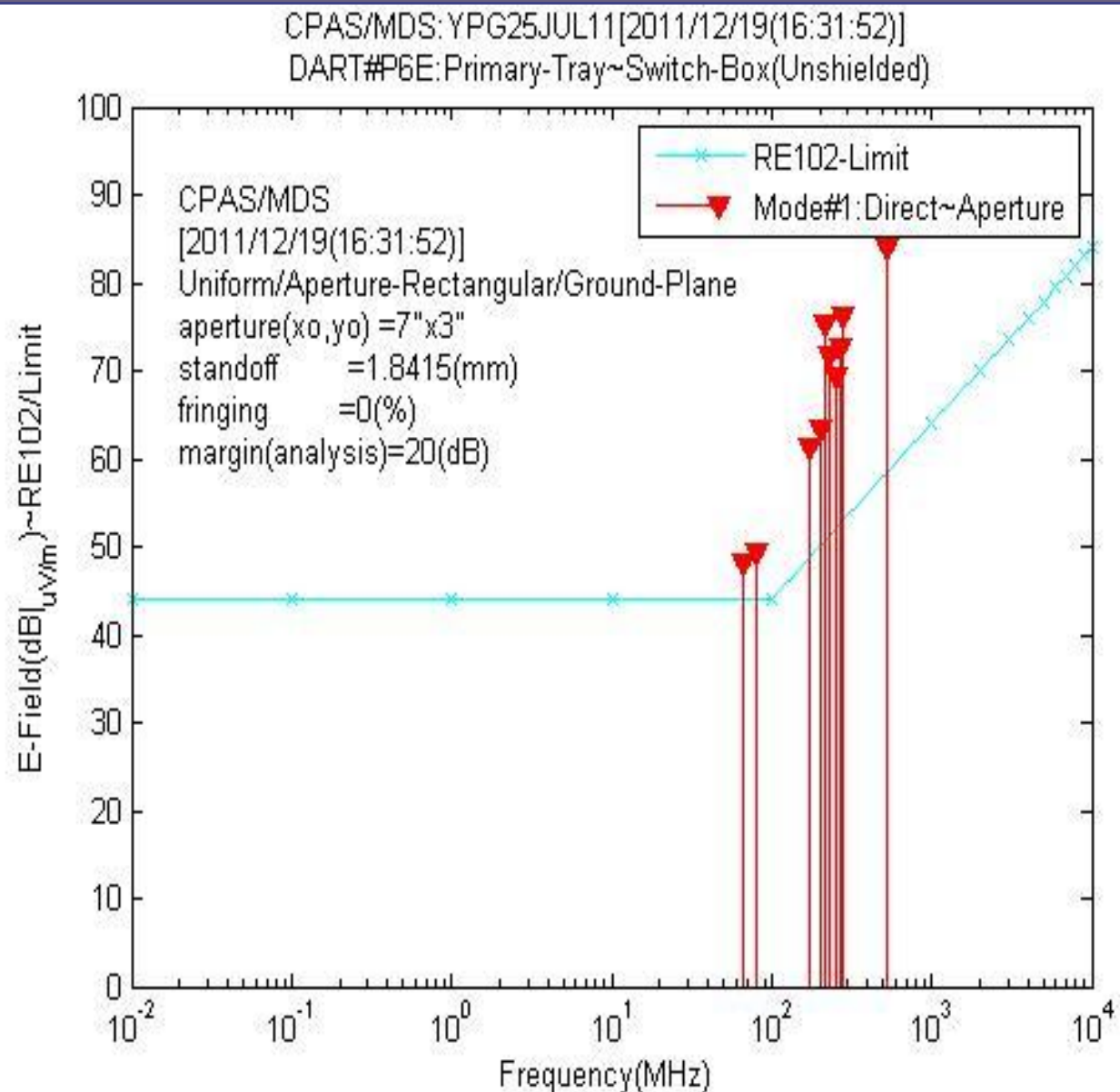


(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



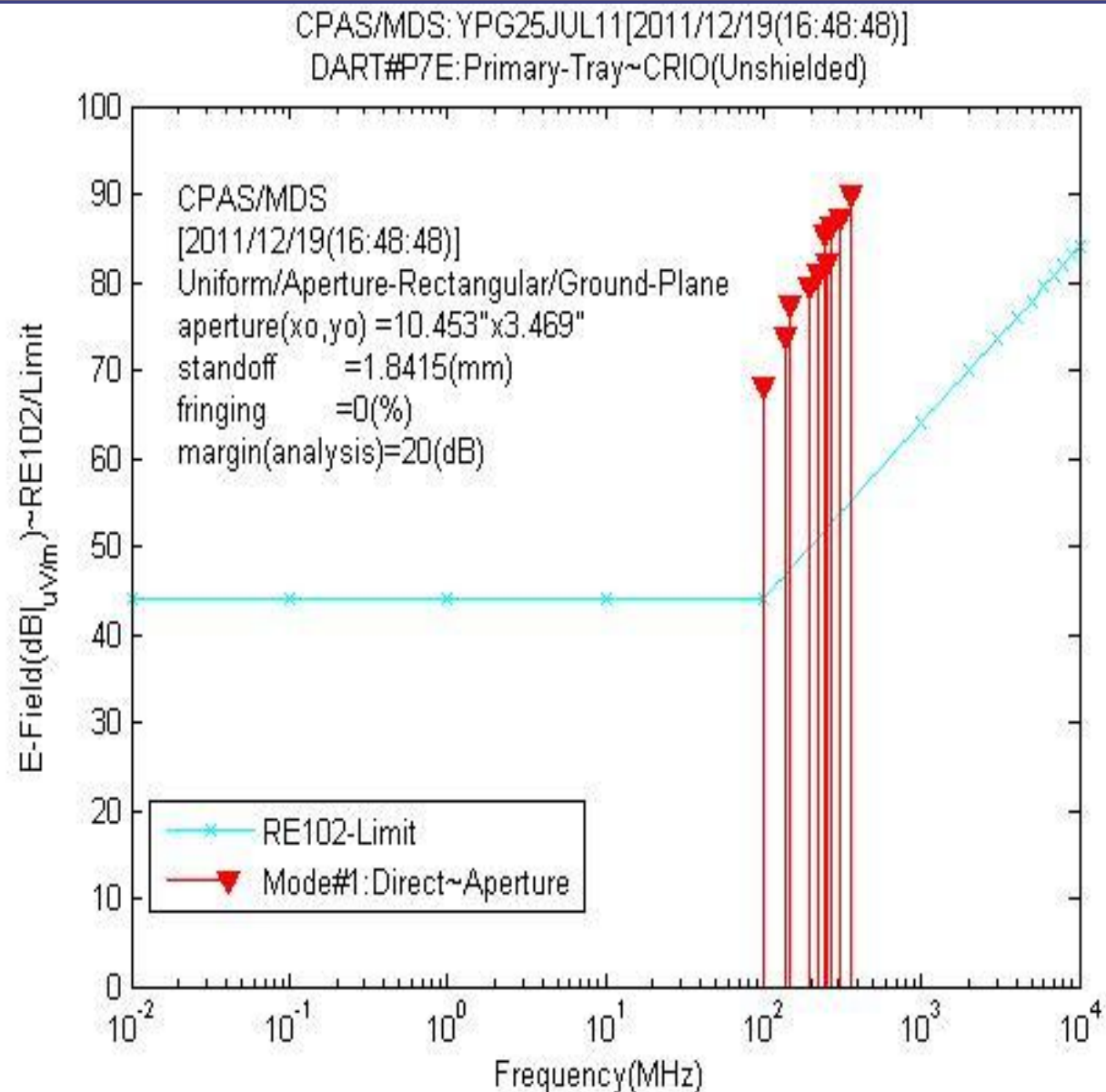


(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



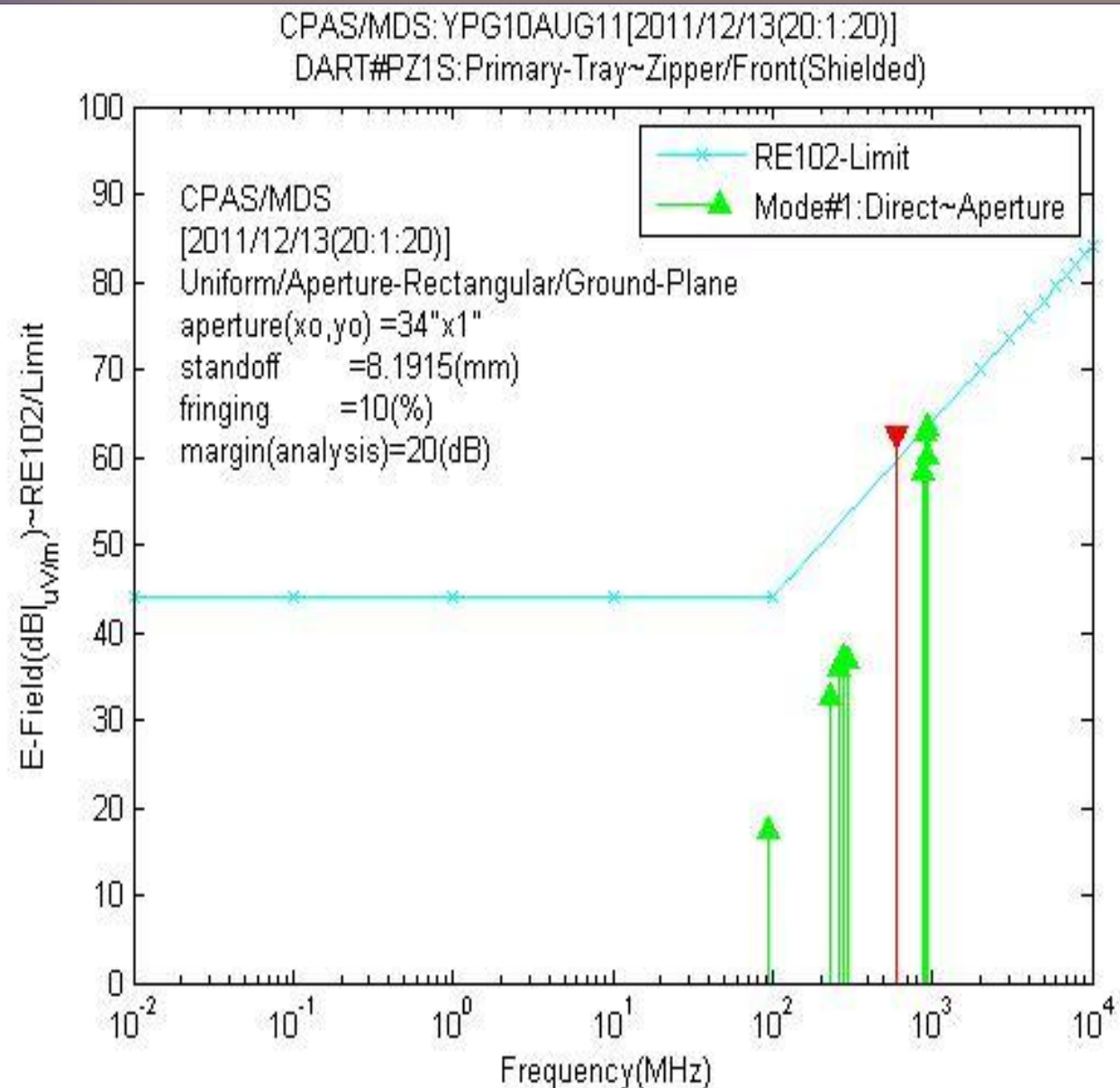


(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded





(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



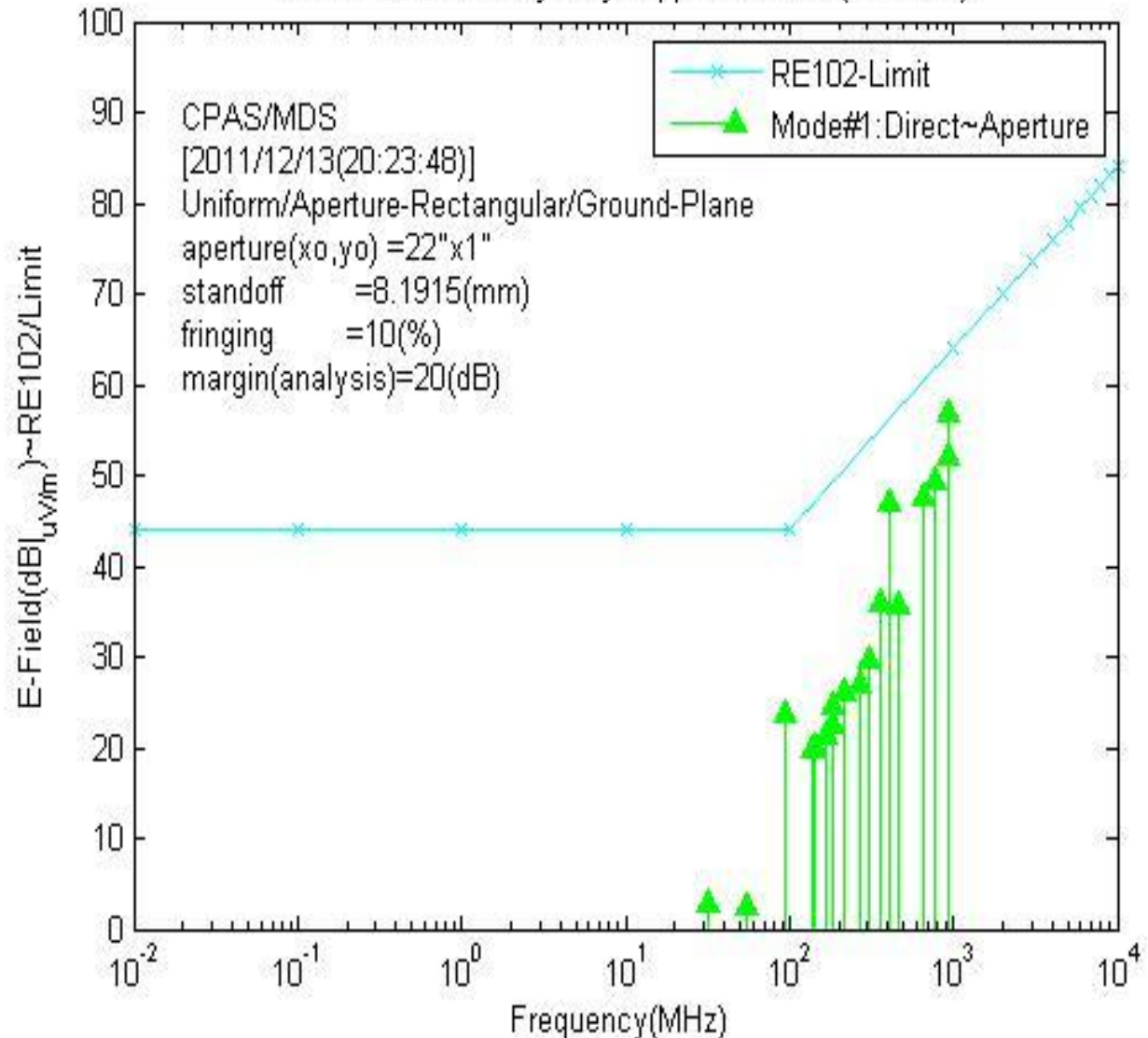


(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



CPAS/MDS: YPG10AUG11[2011/12/13(20:23:48)]

DART#PZ2S: Primary-Tray~Zipper/Side/Left(Shielded)

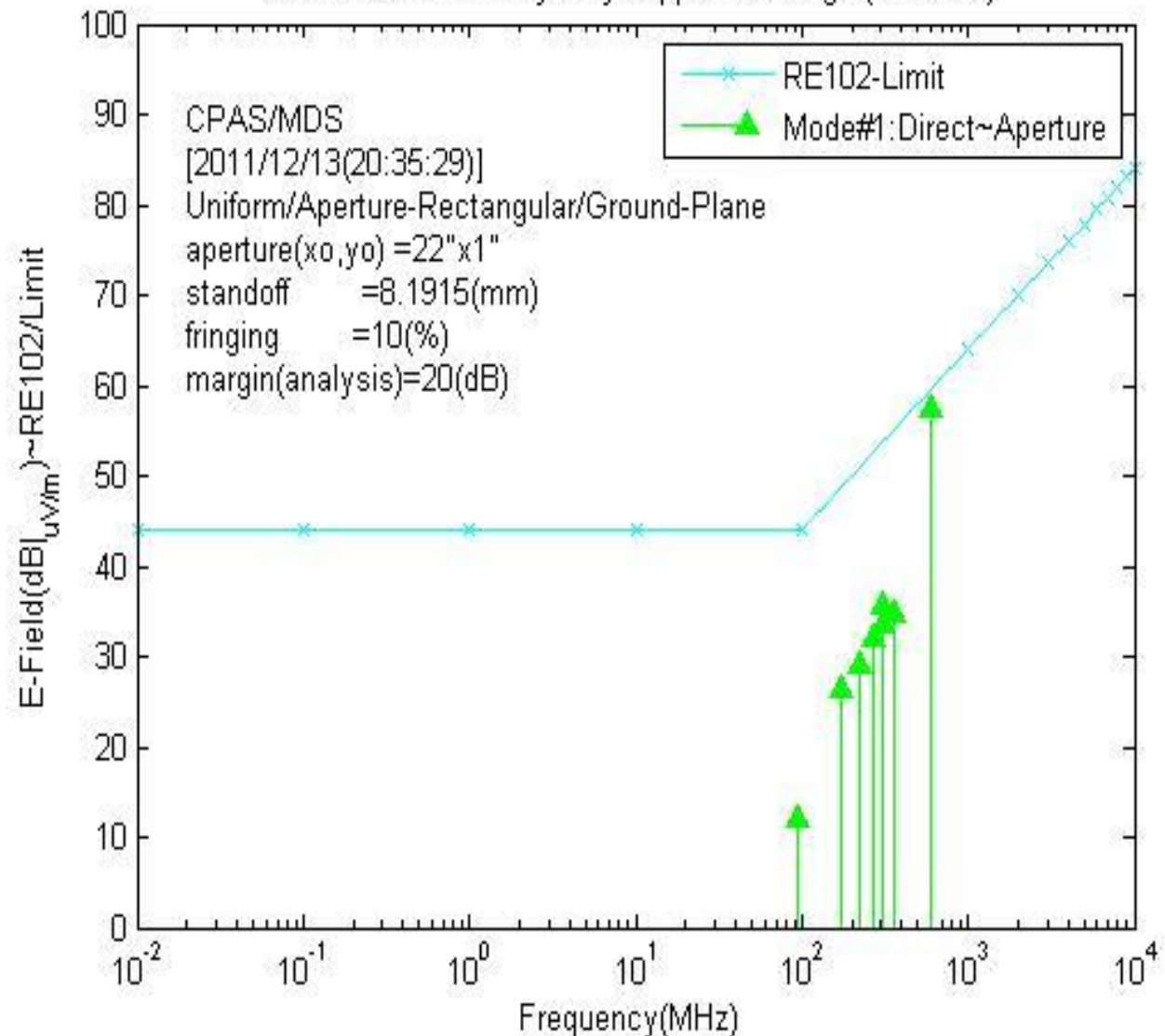




(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded

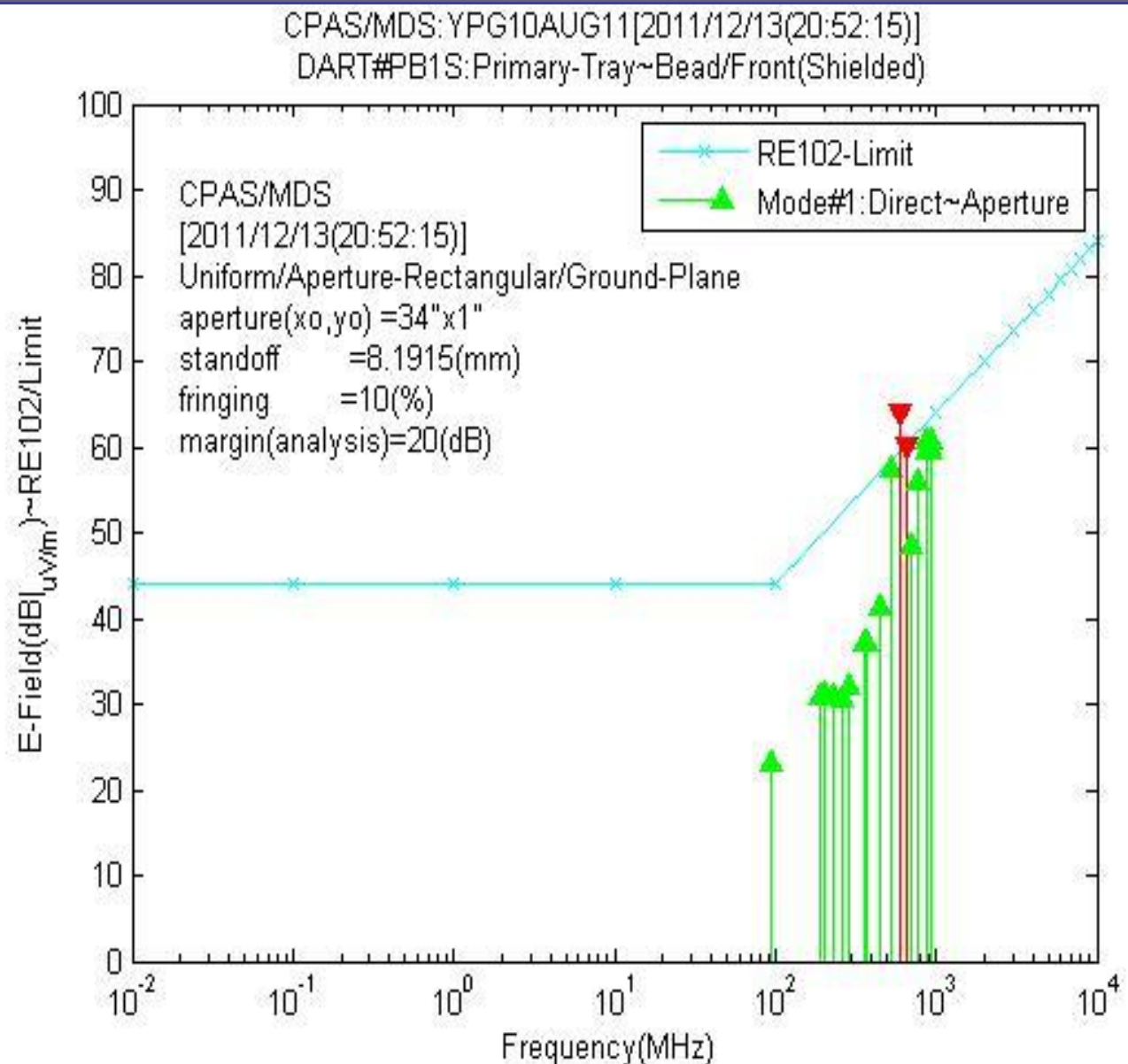


CPAS/MDS: YPG10AUG11[2011/12/13(20:35:29)]
DART#PZ3S:Primary-Tray~Zipper/Side/Right(Shielded)





(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded

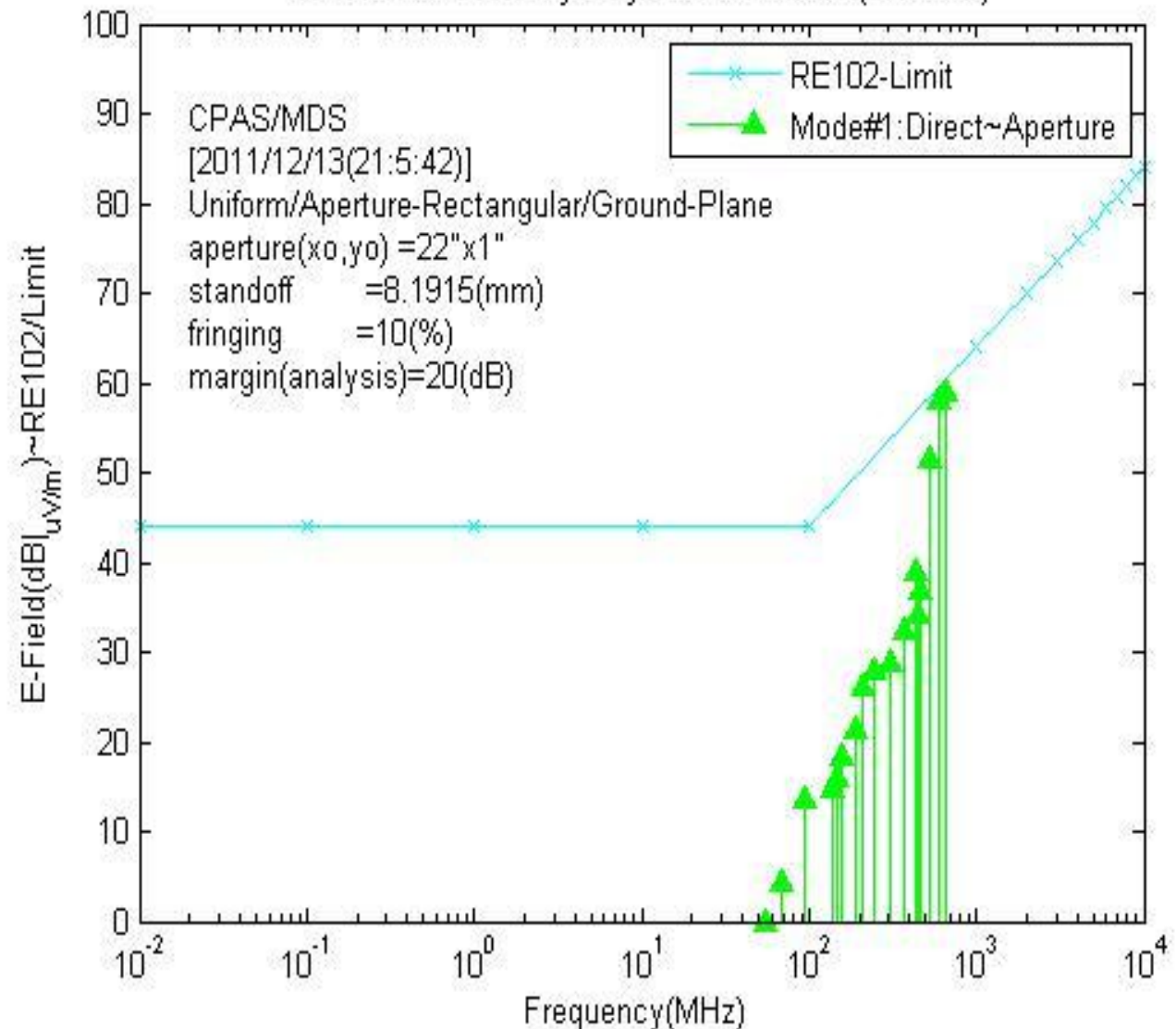




(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded



CPAS/MDS: YPG10AUG11[2011/12/13(21:5:42)]
DART#PB2S: Primary-Tray~Bead/Side/Left(Shielded)

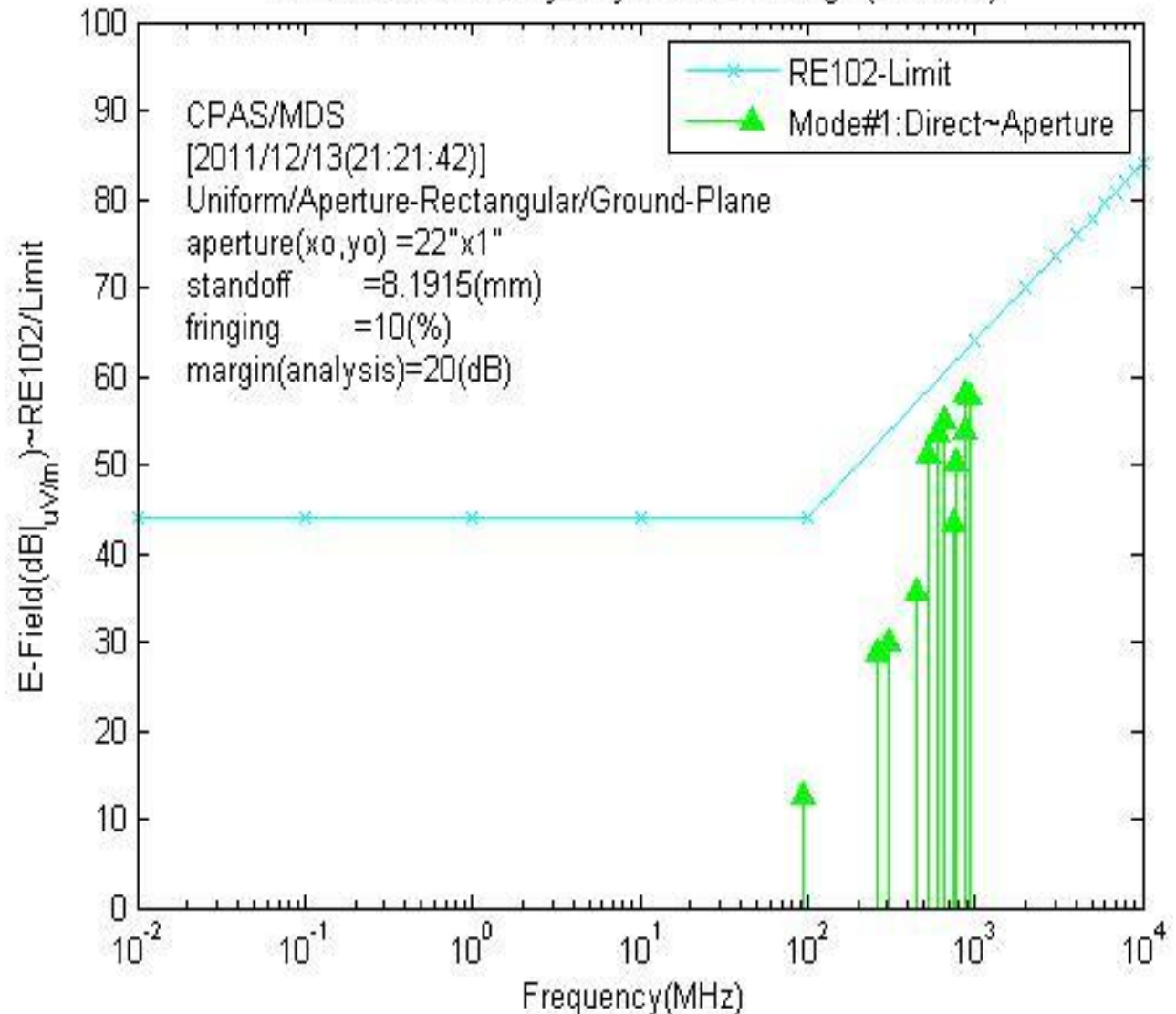




(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded

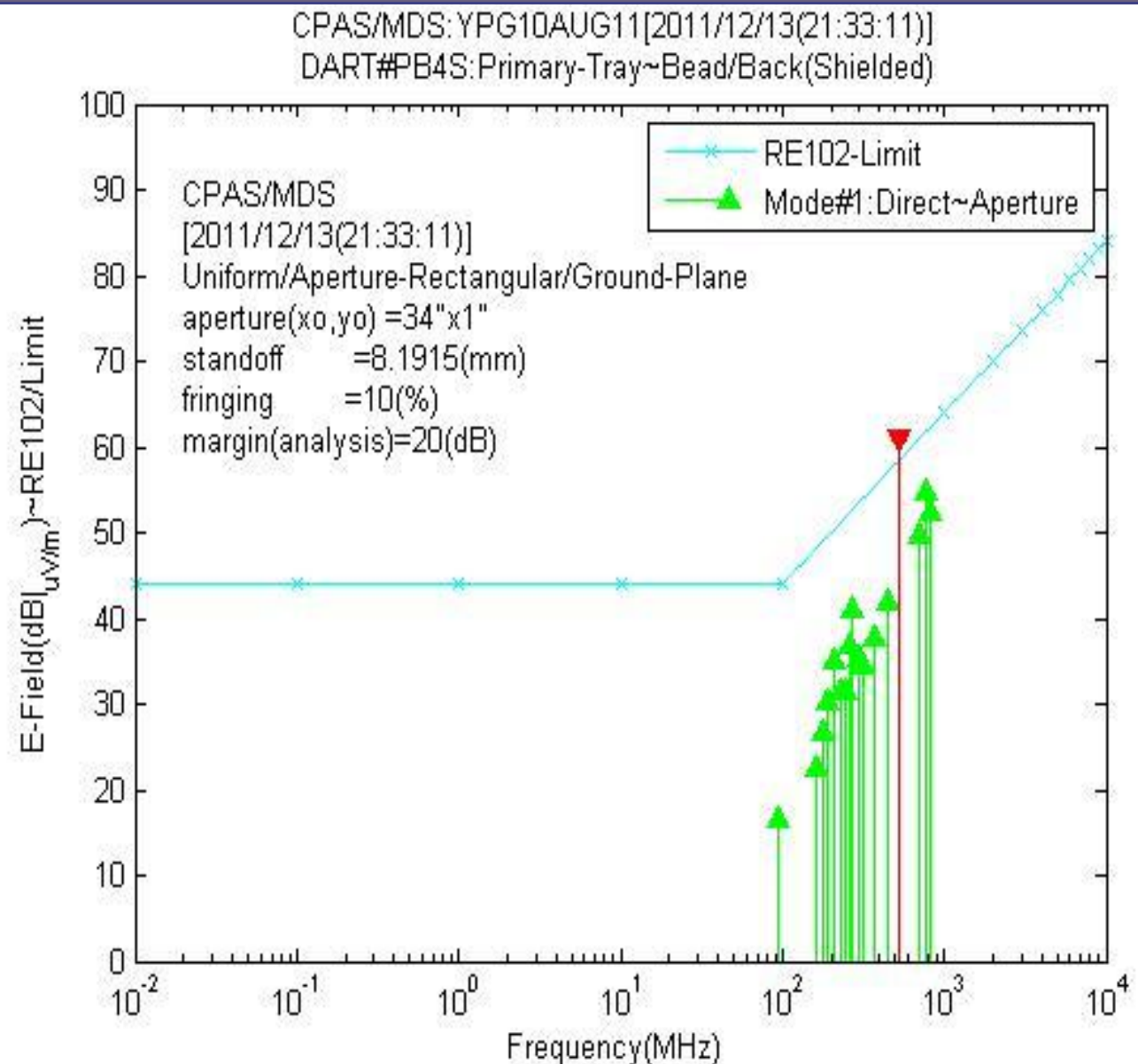


CPAS/MDS: YPG10AUG11[2011/12/13(21:21:42)]
DART#PB3S: Primary-Tray~Bead/Side/Right(Shielded)





(2) YPG/DART: CPAS/MDS Aperture ~ Primary/Unshielded







(2) YPG/DART: YPG Drop Test Chutes/Landing/Recovery





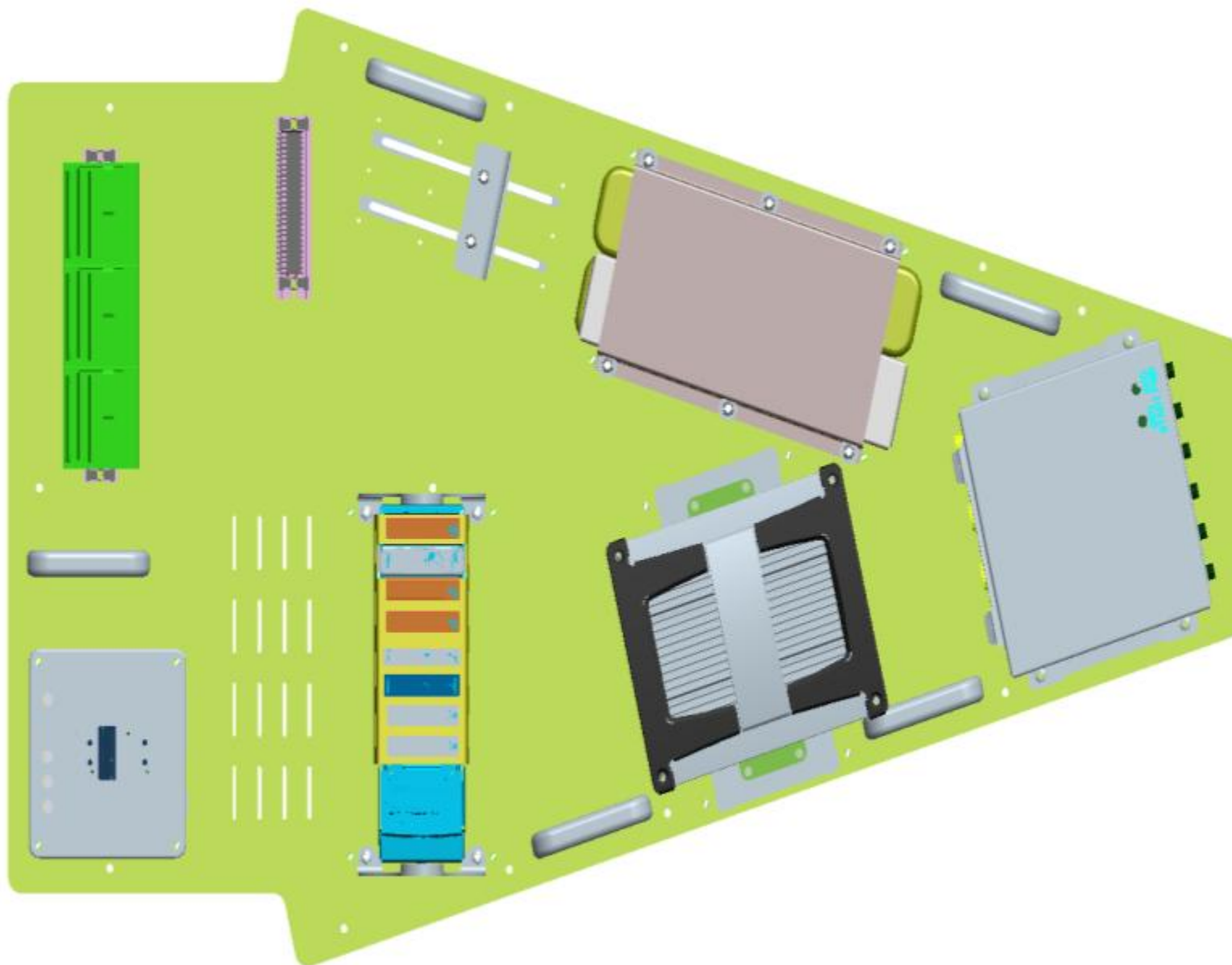
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 - (2) Parts Build-Up (Shielded Components/NF->1m)
 - **(3) Full System Integration ~ Test Vehicle (Shielded Parts/FF->1m)**
 - EMC Results
- Conclusions



(3) YPG/Capsule: CPAS RE02 (SS)





(3) YPG/Capsule: CPAS RE02 (SS) Open Panels





(3) YPG/Capsule: CPAS RE02 (SS) Closed (0 Deg)





(3) YPG/Capsule: CPAS RE02 (SS) Closed (+30 Deg)





(3) YPG/Capsule: CPAS RE02 (SS) Closed (-30 Deg)





(3) YPG/Capsule: CPAS RE02 (SS) Separation Sled





(3) YPG/Capsule: Test/Analysis



- **Test**
 - Circular Scans
 - Probes/Hybrid
- **Analysis**
 - Extrapolated (FF->1m)
 - Attenuated
 - Antenna Factor



(2) YPG/DART: DART Test/Analysis



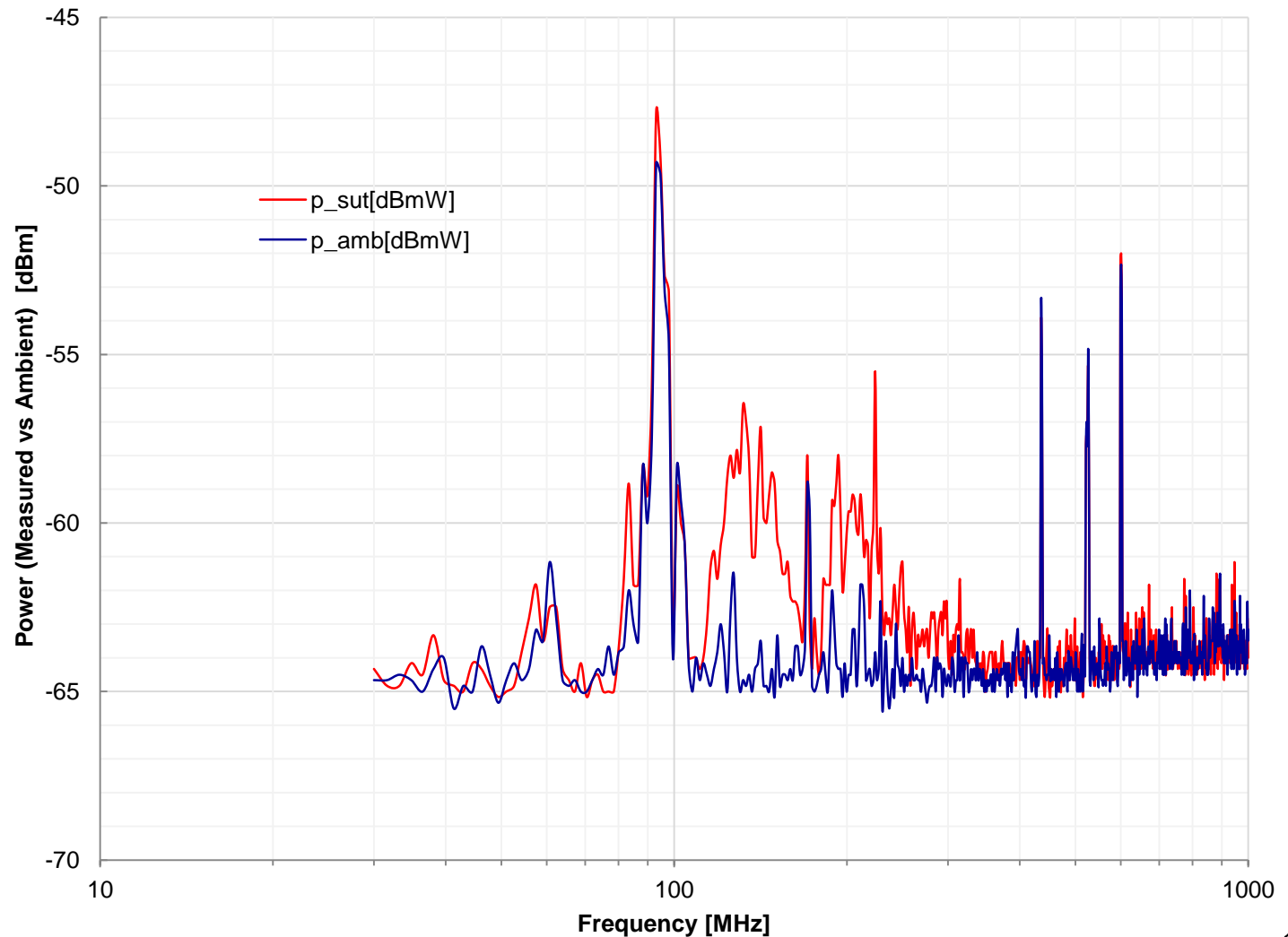
- **Equipment**
 - **CPSS**
 - Primary
 - Secondary
 - **PTV**
 - Open Panels (Unshielded)
 - Closed Panels (Shielded)
 - **Cameras**
- **Measurements**
 - **Continuous Spectrum**
 - Ambient Background Noise
 - Reference Level



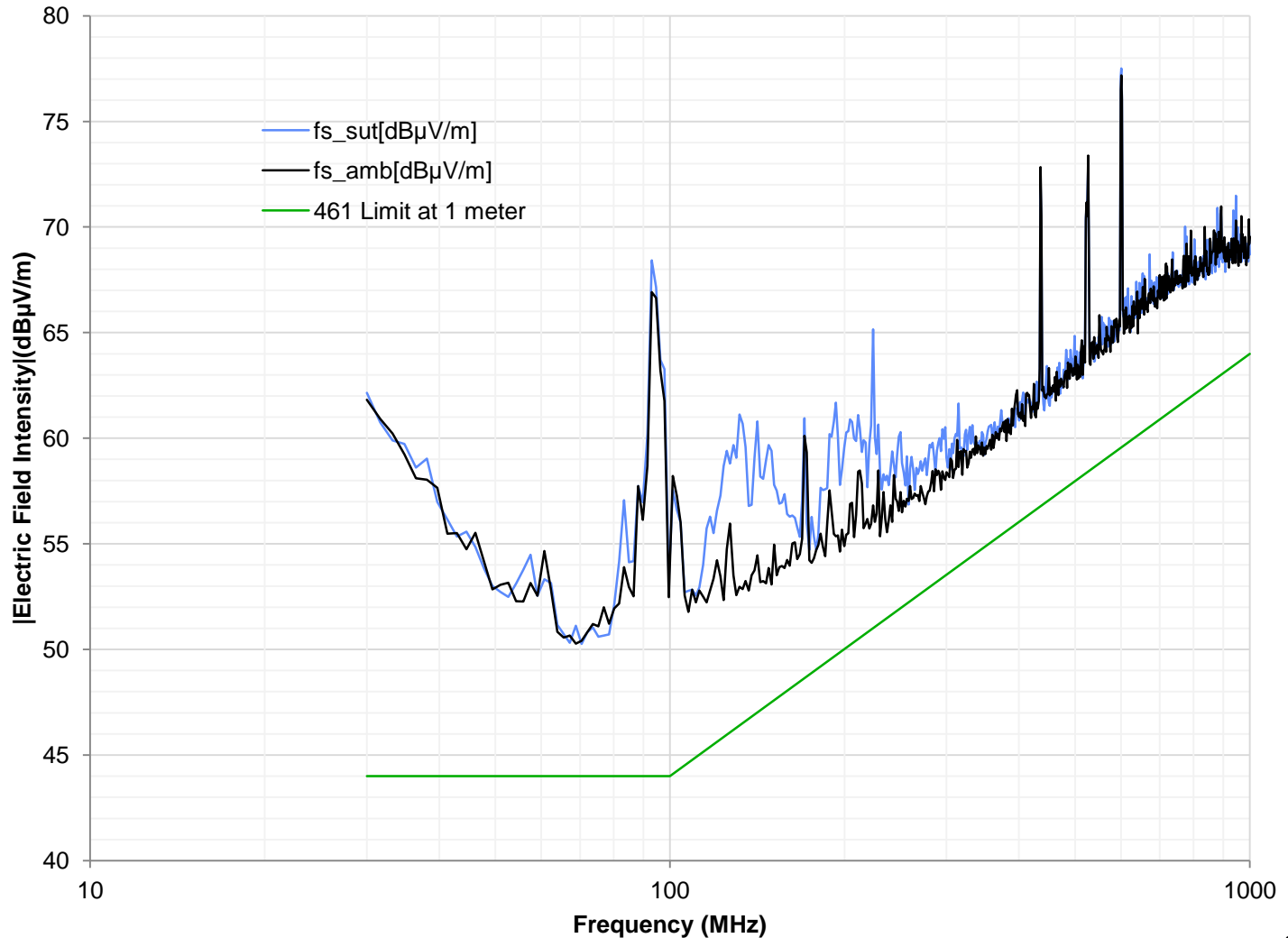
(3) YPG/DART: CPSS Test/Analysis HP/3m Secondary (30-1000 MHz)



CPAS/CPSS ~ 01/HP:3m/SN
Raw Measured Data



CPAS/CPSS ~ 01/HP:3m/SN
Converted Measured Data vs 461 RE102 Limit

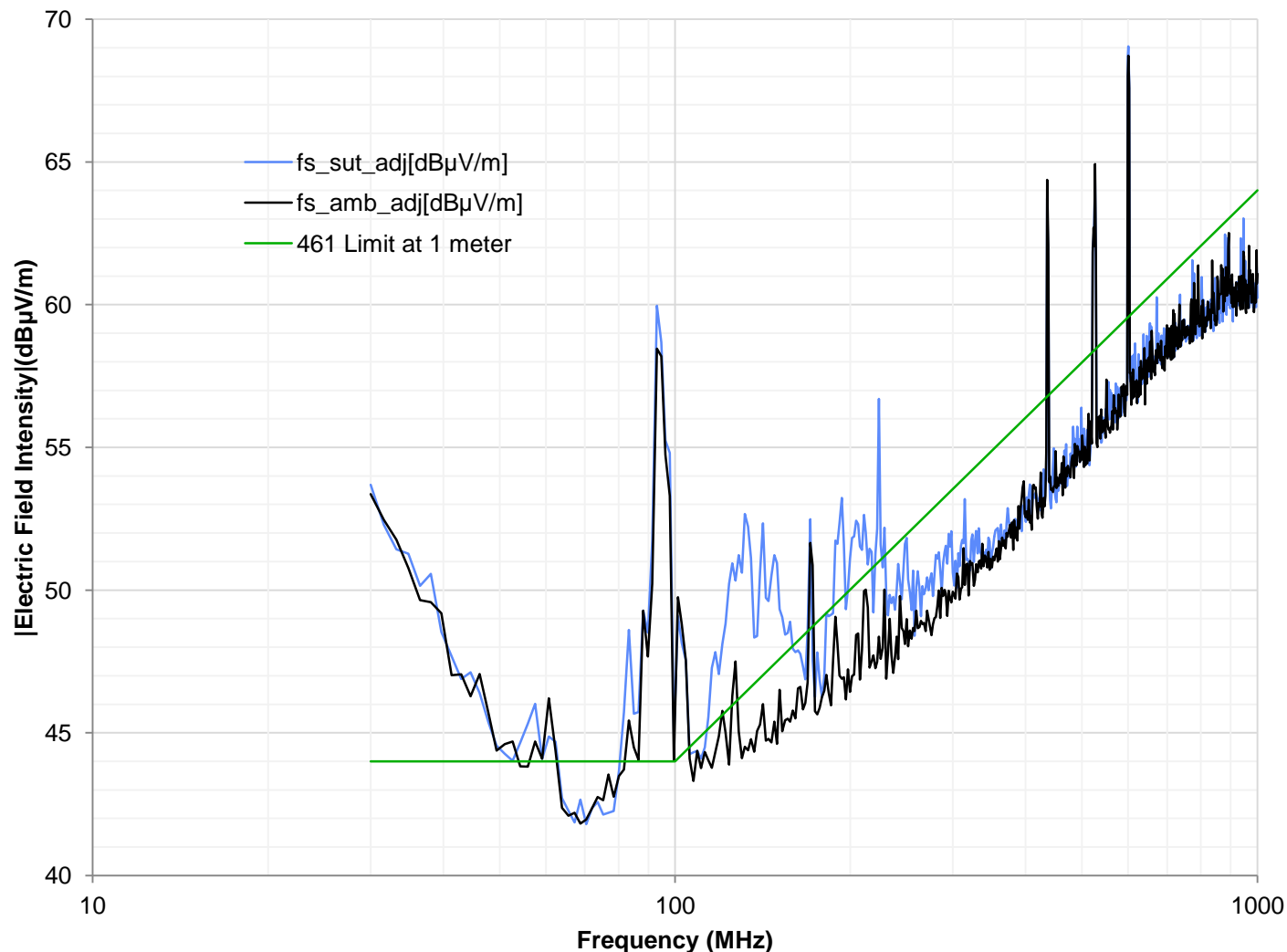




(3) YPG/Capsule: CPSS Test/Analysis HP/3m Secondary (30-1000 MHz)

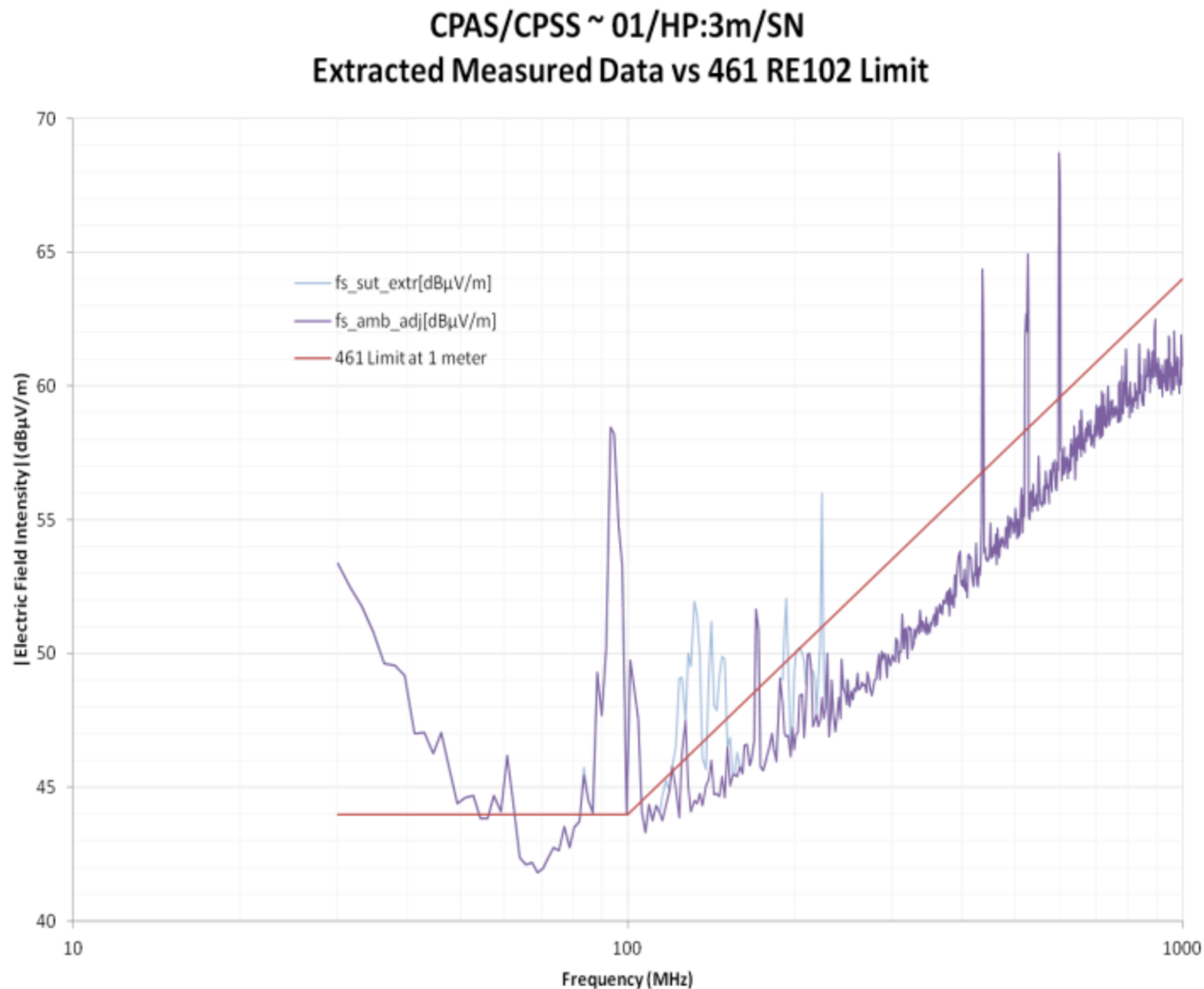


CPAS/CPSS ~ 01/HP:3m/SN Adjusted Measured Data vs 461 RE102 Limit



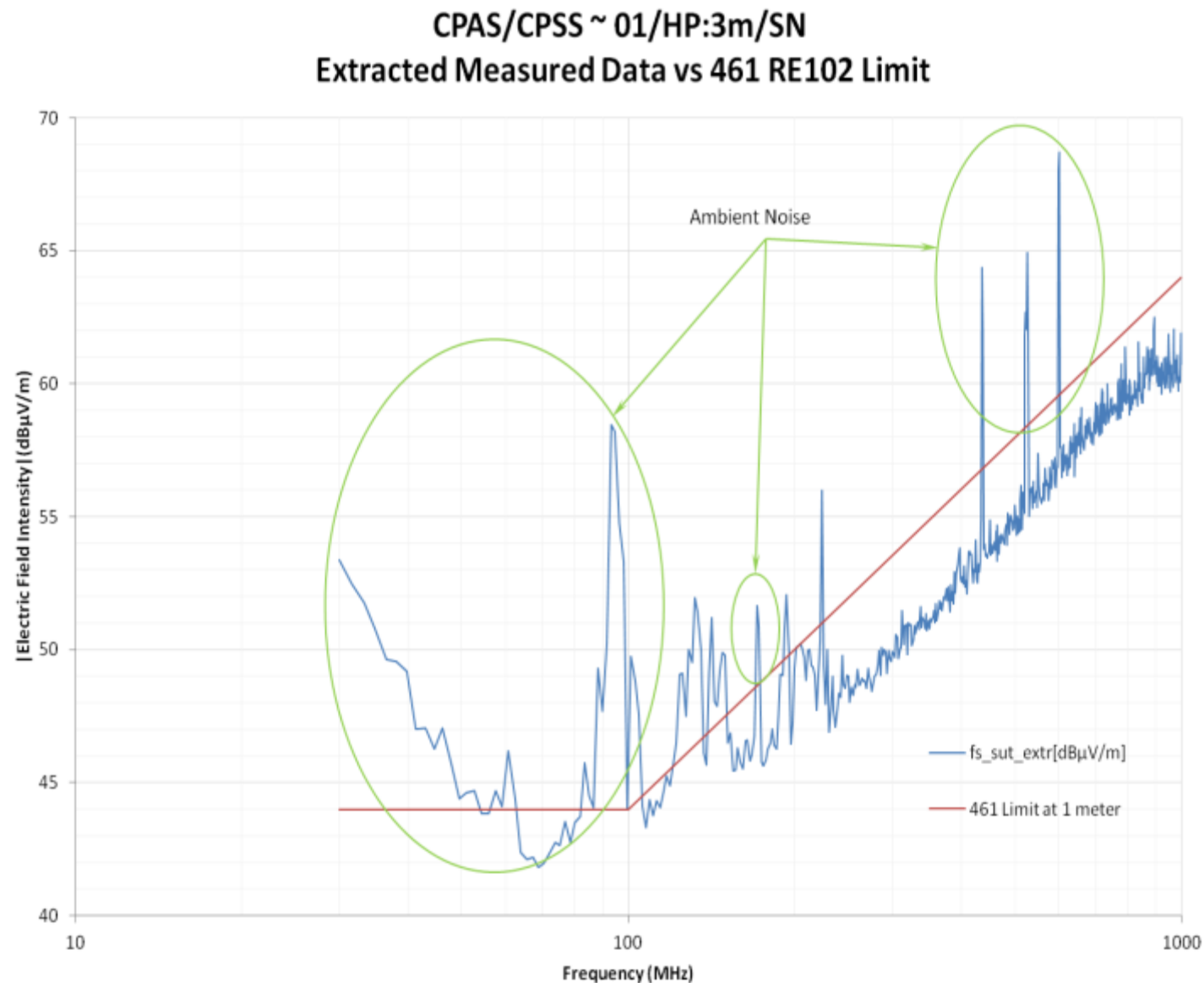


(3) YPG/Capsule: CPSS Test/Analysis HP/3m Secondary (30-1000 MHz)



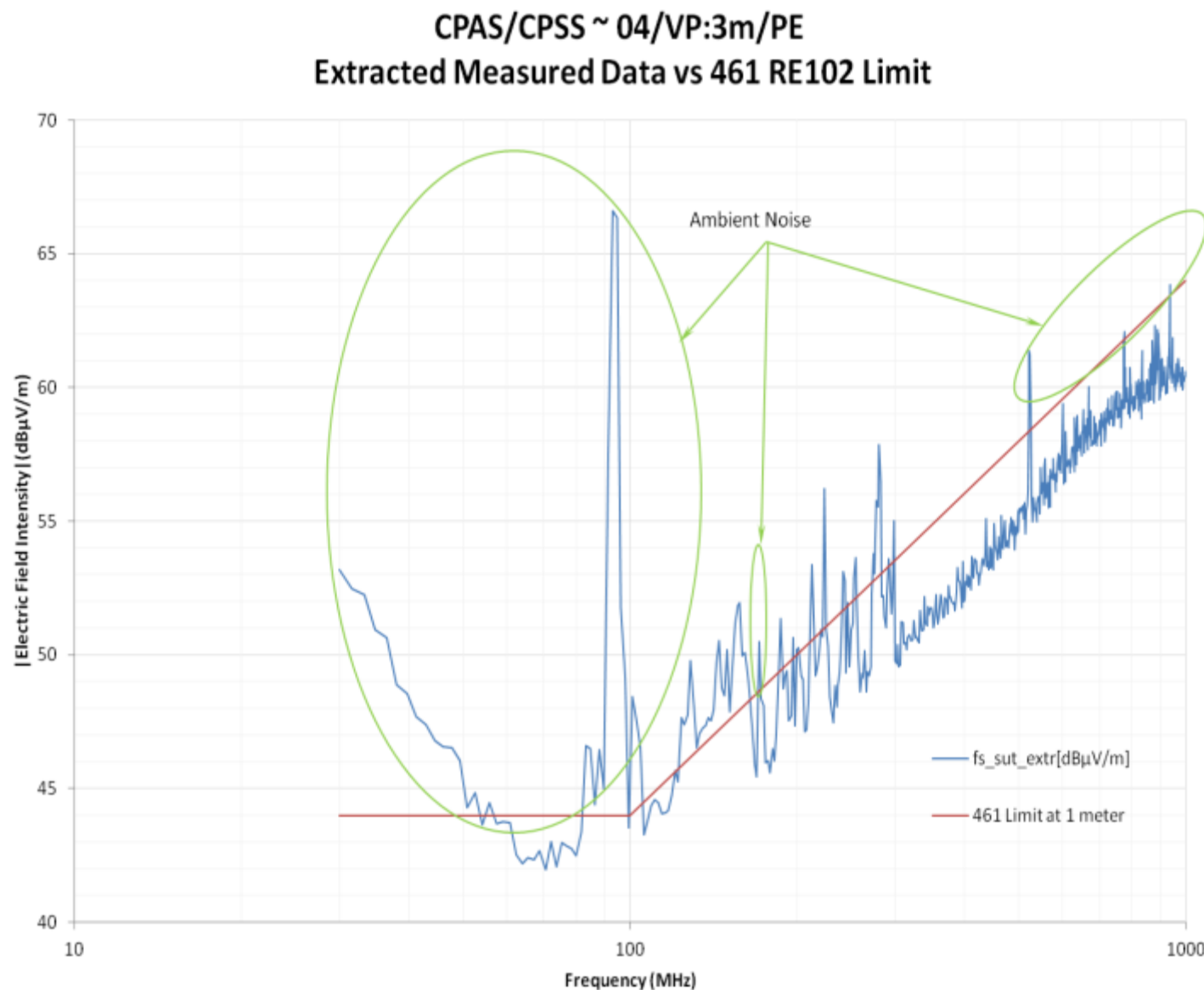


(3) YPG/Capsule: CPSS Test/Analysis HP/3m Secondary (30-1000 MHz)



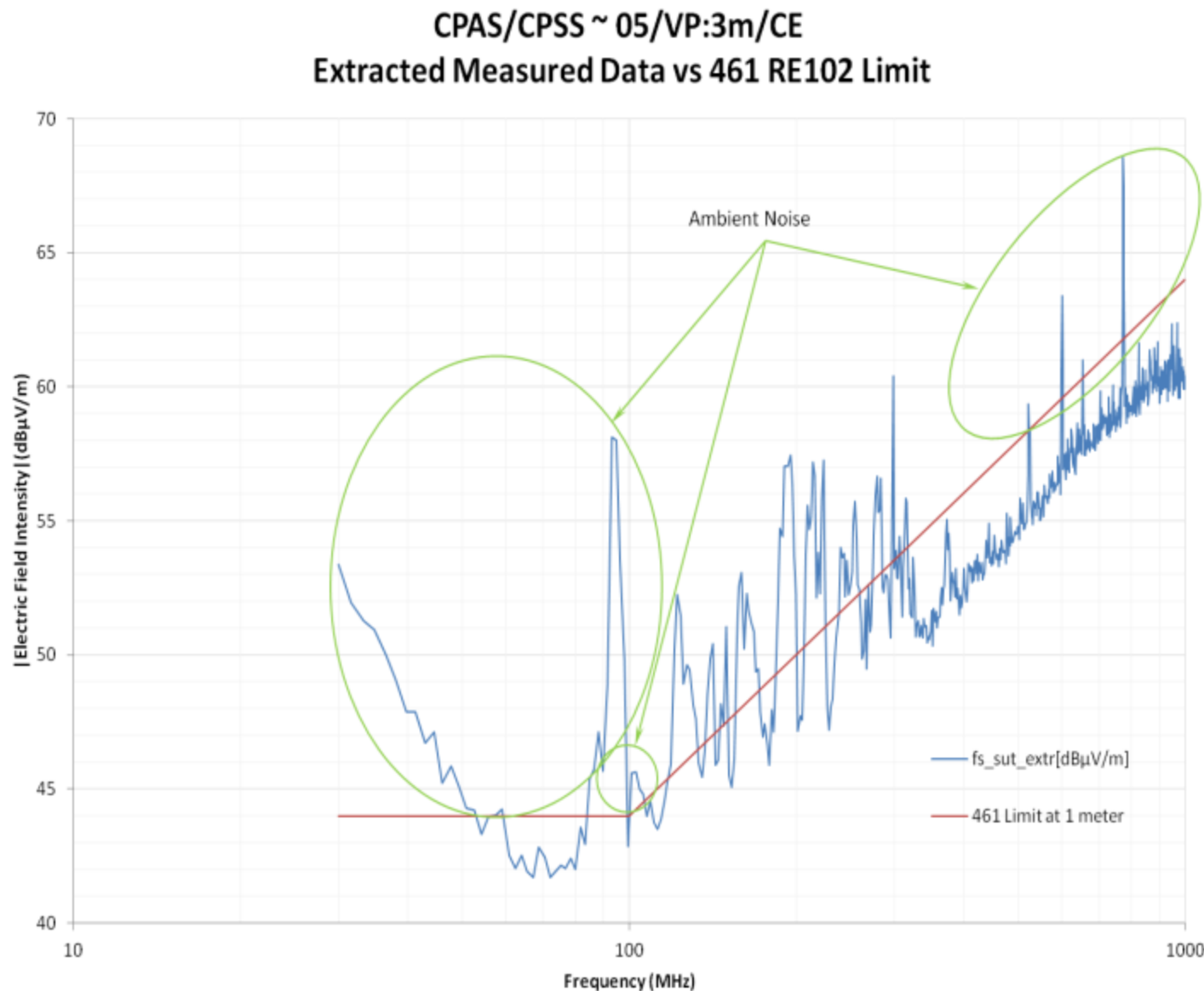


(3) YPG/Capsule: CPSS Test/Analysis VP/3m Primary (30-1000 MHz)



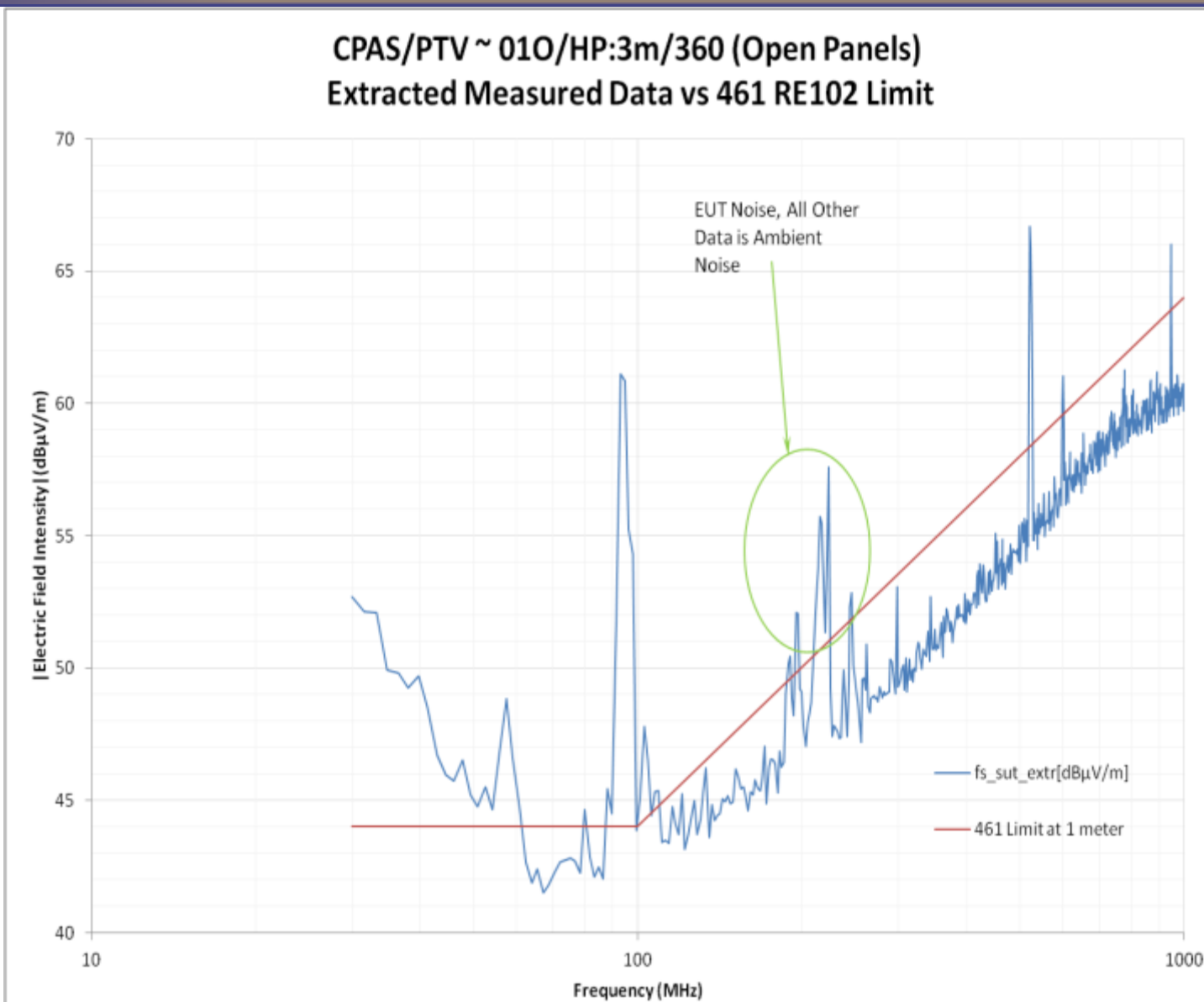


(3) YPG/Capsule: CPSS Test/Analysis HP/3m Cameras (30-1000 MHz)





(3) YPG/Capsule: PTV Test/Analysis HP/3m 360/Open (30-1000 MHz)

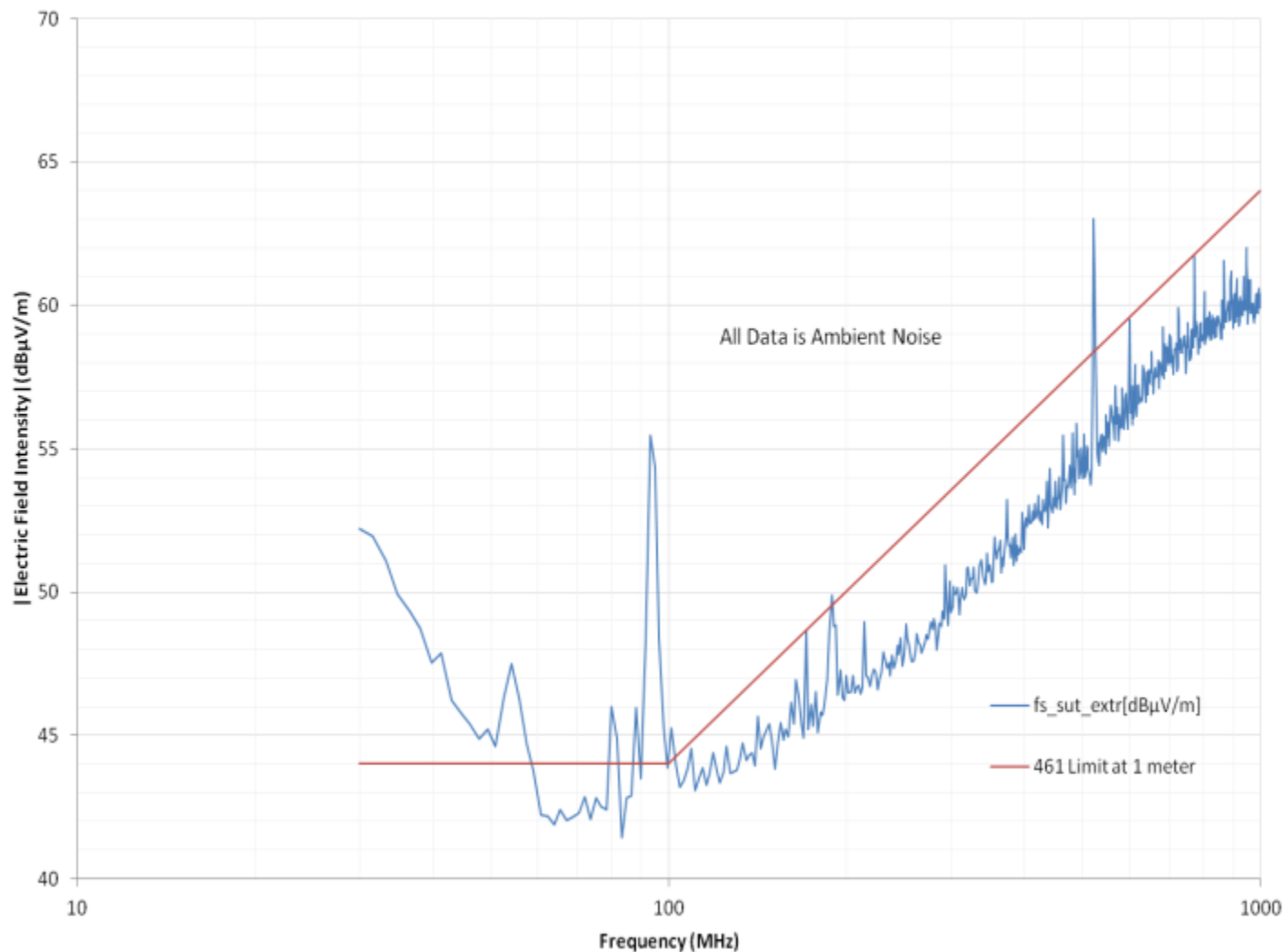




(3) YPG/Capsule: PTV Test/Analysis VP/3m 180/Open (30-1000 MHz)



CPAS/PTV ~ 050/VP:3m/180 (Open Panels)
Extracted Measured Data vs 461 RE102 Limit

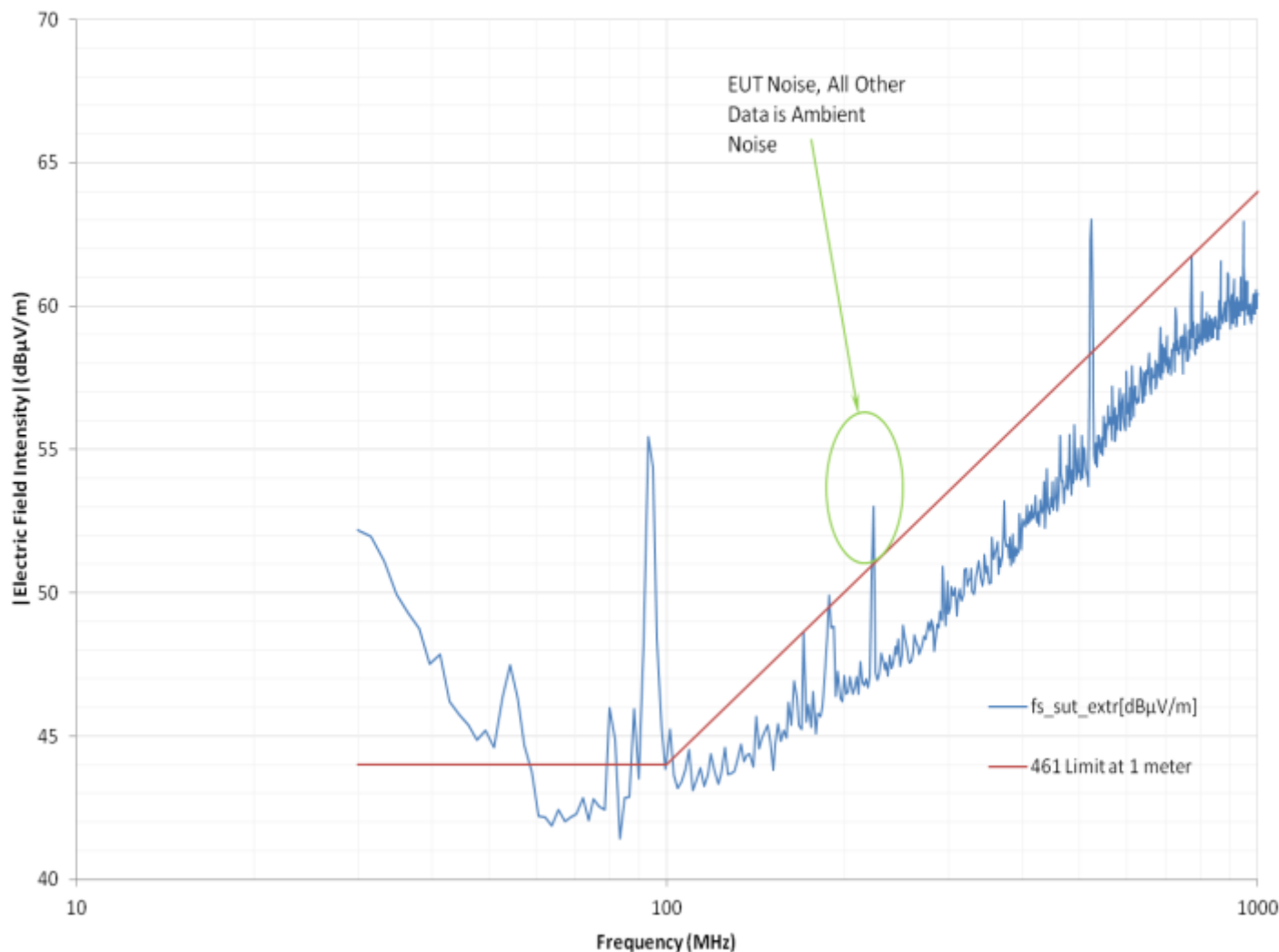




(3) YPG/Capsule: PTV Test/Analysis HP/3m 360/Closed (30-1000 MHz)

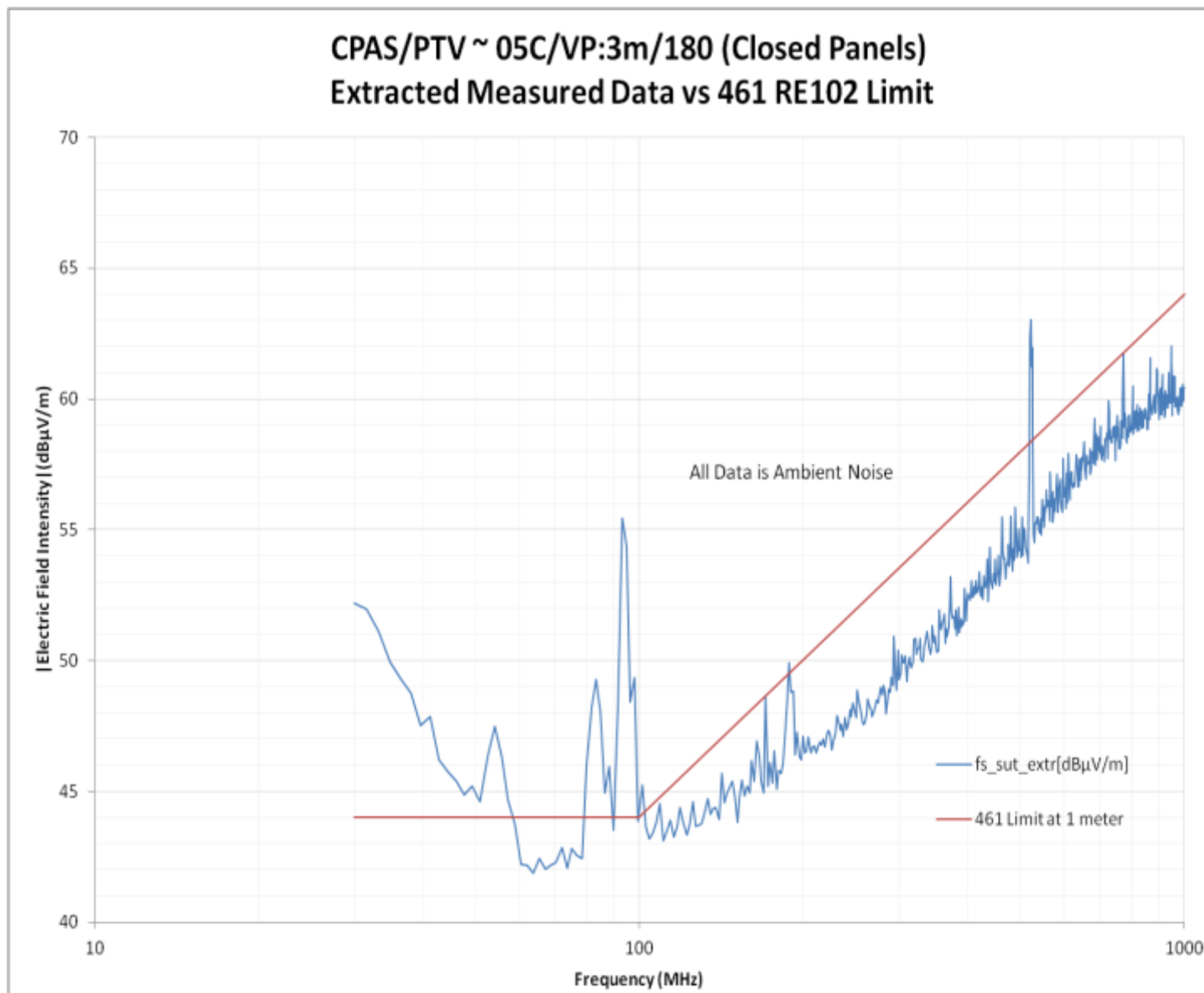


CPAS/PTV ~ 01C/VP:3m/360 (Closed Panels)
Extracted Measured Data vs 461 RE102 Limit





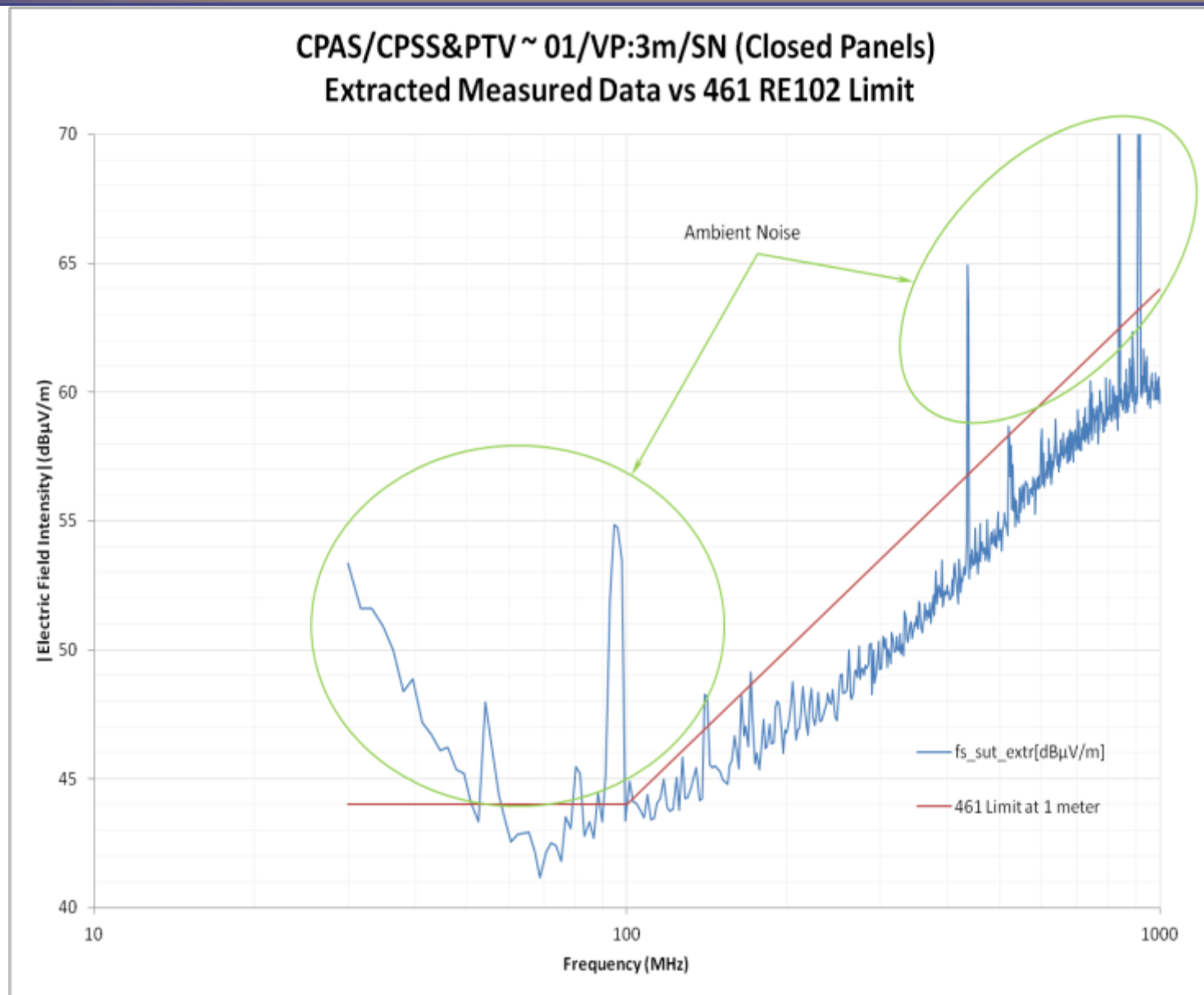
(3) YPG/Capsule: PTV Test/Analysis VP/3m 180/Closed (30-1000 MHz)





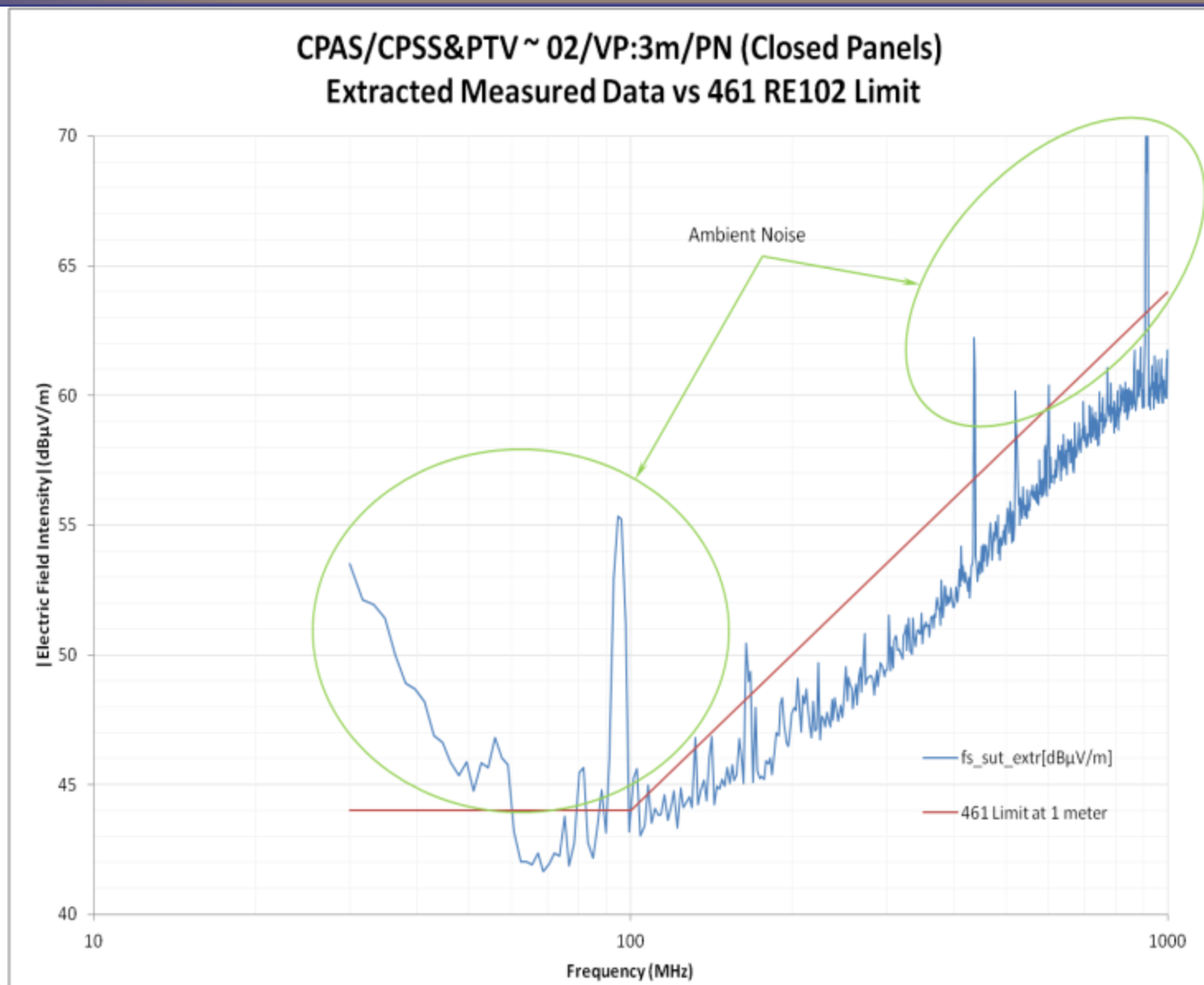
(3) YPG: CPSS/PTV Test/Analysis

VP/3m Secondary/Closed (30-1000 MHz)





(3) YPG: CPSS/PTV Test/Analysis VP/3m Primary/Closed (30-1000 MHz)





(3) YPG/Capsule: CPAS C17/Load





(3) YPG/Capsule: YPG Drop Test C17



- **Experiments (EMI)**

- **Avionics**

- Position/Velocity/Acceleration
 - Temperature/Pressure/Humidity
 - Loading(Forces/Torques)

- **Delivery System**

- Firing Events
 - Deploy
 - Release
 - Mortars/Cutters

- **Video**

- Cameras





(3) YPG/Capsule: YPG Drop Test C17



- SoF



Full System Test
CPAS EDU-A-CDT-3-3
PTV / CPSS Test Vehicle
C-17 Aircraft Extraction
Army Yuma
Proving Grounds
February 29, 2012





(3) YPG/Capsule: YPG Drop Test





(3) YPG/Capsule: YPG Drop Test Recovery/Repair/Refurbish/Reuse





Conclusion



- **SoF Confirmed**
 - Components
 - Build-Up
 - System
- **Tests/Apertures**
 - NF->1m Results
 - FF->1m Results
- **Successful Drop Test**
 - No Anomalies
 - C130/C17
 - CPAS (Shielding)